AD-A053 964 WYLE LABS HUNTSVILLE ALA F/G 13/12
CAUSE IDENTIFICATION ANALYSIS OF FATAL ACCIDENT DATA FOR CANOES--ETC(U)
FEB 78 C SAUTKULIS, R DOUGLAS, K GEISSLER DOT-CG-40672-A
UNCLASSIFIED MSR-78-4 USCG-D-17-78 NL

1 OF 3
AD A053964


OF 3
3964

Report No. CG-D-17-78

CAUSE IDENTIFICATION
ANALYSIS OF FATAL ACCIDENT DATA FOR
CANOES/KAYAKS/INFLATABLE CRAFT

FINAL REPORT

FEBRUARY 1978

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
United States Coast Guard
Office of Research and Development
Washington, D.C. 20590

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

The contents of this report do not necessarily reflect the official view or policy of the Coast Guard; and they do not constitute a standard, specification, or regulation.

This report, or portions thereof may not be used for advertising or sales promotion purposes. Citation of trade names and manufacturers does not constitute endorsement or approval of such products.

(18) USCG (19) D-17-78

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
CG-D-17-78		

(6) **4. Title and Subtitle**
CAUSE IDENTIFICATION ANALYSIS OF FATAL ACCIDENT DATA FOR CANOES/KAYAKS/INFLATABLE CRAFT

(11) **5. Report Date**
Feb[illegible] 1978

6. Performing Organization Code

(10) **7. Author(s)**
C. Sautkulis, R. Douglas, K. Geissler and R. White

(14) **8. Performing Organization Report No.**
MSR-78-4

9. Performing Organization Name and Address
Wyle Laboratories
P. O. Box 1008
Huntsville, Alabama 35807

10. Work Unit No. (TRAIS)
G-DSA 3503.1.5.1

(15) **11. Contract or Grant No.**
DOT-CG-40672-A (T.O. #19)

12. Sponsoring Agency Name and Address
U. S. Department of Transportation
United States Coast Guard
Office of Research and Development
Washington, D. C. 20590

(13) **13. Type of Report and Period Covered**
Final Report
Feb[illegible]76-Jan[illegible]77

14. Sponsoring Agency Code
USCG (G-DSA)

15. Supplementary Notes
U.S. Coast Guard Project Officer: Geoffrey Fuller (G-DSA-2)

(12) 196 p.

16. Abstract

Fatal Accident Data was used to identify the major causes of fatalities resulting from the use of canoes, kayaks, and inflatable craft.

Areas of potential safety enhancement were evaluated using the available data. PFD availability and wear appear to be areas that need to be further evaluated to develop safety programs to reduce the number of fatalities in canoes and inflatables. Increased vessel flotation appears to be a potential safety enhancement concept for canoes but not for inflatables. Data for kayaks was too limited to form any conclusions.

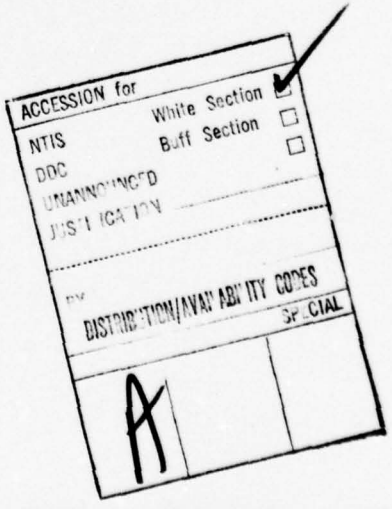
17. Key Words	18. Distribution Statement
Cause Identification Canoes, Kayaks, Inflatable Craft Safety Enhancement Data Analysis	Document is available to the U. S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	206	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

405 950

TABLE OF CONTENTS



LIST OF FIGURES

LIST OF TABLES

CAUSE IDENTIFICATION ANALYSIS OF FATAL ACCIDENT DATA FOR CANOES/KAYAKS/INFLATABLE CRAFT

1.0 INTRODUCTORY SUMMARY

The objective of this Cause Identification Effort was to identify predominant accident or recovery failure causes, and to indicate problem areas. These areas may then be subjected to further analysis in subsequent research efforts, leading to the formulation of potential safety enhancement programs. This introductory section presents the organization of the report and a summary of the major findings.

The effort reported herein consists of an analysis of fatal accident data to establish whether or not the potential exists to reduce canoe, inflatable, and kayak fatalities through one or more of the following means:

- Increased Flotation Requirements
- Improved Education Program
- Improved PFD design/education or carriage requirement enforcement programs.

Section 2.0 describes how this project developed from an initial interest on the part of the U. S. Coast Guard in determining whether recently established standards for level flotation in small outboard boats would also be useful in reducing fatalities involving canoes.

Section 3.0 evaluates the scope of the problem regarding canoe related fatalities. A comparison of the fatality rates for canoes and "level flotation affected boats" was made using three rate bases: number of boats in existence, number of boat hours, and number of passenger hours for a given year.

Section 4.0 describes the origin of the data base and the methodology used for data classification and coding. A very important limitation is placed on the interpretation of this data for two reasons: 1) Data used was for fatal accidents only, 2) there was a large number of unknown values in the data base.

The limitation inherent in the first restraint is that without some measure of exposure or knowledge of "near-misses", the relative risk data required to evaluate the effectiveness of existing programs in the education and enforcement areas cannot be extracted (e.g., it cannot be determined how much more likely to survive is an instructed or experienced boater compared to an uninstructed or inexperienced boater).

Additional restrictions are imposed by the second restraint in that information necessary to answer many questions which were asked of the raw accident data was absent in a high (often as much as 75%) proportion of the cases reviewed.

Section 5.0 describes the organization of the coded data into descriptive profiles.

Section 6.0, 7.0, and 8.0 contain the data analysis for canoes, inflatables, and kayaks, respectively. For each category of craft, the areas of boater education, PFD availability/use, and vessel flotation are considered. Characteristics of accidents for each type of craft are analyzed with respect to boat particulars, occupant characteristics, environment at the time of accident, and accident dynamics.

Section 9.0 summarizes the results and conclusions in terms of the three vessel types and three potential areas for safety enhancement.

Contained in Appendices A, B, and C, respectively, are: detailed coding instructions for canoe, kayak, and inflatable accidents; descriptive profiles and elements for accident data bases; and cross sorts of coded variables.

Following is a summary of the findings of this effort.

- Relative to flotation: Increased flotation for canoes appears to have a fatality reduction potential roughly on par to level flotation for outboards. However, due to the apparently higher fatality rate for canoes, the benefit to cost ratio for canoes may be nearly twice that for outboards. The fatality reduction potential due to increased flotation in inflatables appears nonexistent; whereas, in kayaks, the reduction potential could not be assessed due to the low number of kayak fatalities using the two years of data covered by this study.

- Relative to PFD availability/use: It was found that PFD availability and use rates are currently very low for people involved in fatal accidents. This suggests a need for education programs and stricter enforcement of carriage requirements. The fact that a number of fatalities occurred when PFDs were available but not worn should be stressed in education programs. It was found that PFD usage in rapids or other turbulent water conditions does not appear to significantly affect survivability. However, it is likely that this finding is a result of the lack of information on non-fatal accidents. In addition, the low wear rate for PFDs, coupled with low survival times and

short times to rescue, all support inflatable devices (PFDs) as a potential solution for further study. These conclusions concerning canoe-related accidents also hold true for inflatable related accidents; however, insufficient fatalities per year again precluded meaningful conclusions concerning kayaks.

- Relative to education: Without rate data, it could not be determined whether educated boaters actually have lower fatality rates than uneducated boaters. However, it can be seen that most victims had not been reached by formal education programs. This means that beefing up existing programs without reaching more canoeists would have limited potential. The tables in Section 9.0 provide a description of a typical accident which education programs should strive to prevent in addition to descriptive information on the target population. As is shown in this report, most fatalities involve owned (not rented) canoes which are commercially manufactured. The latter information points in the direction of possible educational material contained within the owner's manual or handed out by dealers at the time of sale. The relatively young age of most victims points to programs aimed at the younger end of the boater population, with possible emphasis on scouting programs or seminars. As can be seen from the data, the above appears to apply uniformly to canoes and inflatables. There is little reason at this point to believe that the kayak data would be different, but the small number of accidents involved and high number of unknown responses again limited the depth of kayak accident analysis.

The following summarizes the major findings:

SUMMARY OF MAJOR FINDINGS

	CANOES	INFLATABLES	KAYAKS
Scope of Problem	Average 113 Fatalities per Year (for Data Base Used). Fatality rate 1.7 to 2.2 times greater than for outboard boats.	Average 43 Fatalities per Year. Rate data not available.	Average 9 Fatalities per year. Rate data not available.
Findings Relative to Flotation Regulation	Appears that some form of increased flotation may prevent 28.3% of the fatalities per year.	Flotation does not appear to be potential safety area. In only one case studied did inflatable puncture and sink.	Insufficient fatalities over two year period to draw conclusions.
Findings Relative to PFD Regulation	PFDs are not generally worn or accessible, and in many cases are not on board. Inflatable PFDs appear to warrant further consideration.	PFDs are not generally worn or accessible, and in many cases are not on board. Inflatable PFDs appear to warrant further consideration.	Insufficient fatalities over two year period to draw conclusions.
Findings Relative to Education Programs	Most victims have little experience and have not been instructed in the use of boats.	Most victims have little experience and have not been instructed in the use of boats.	Insufficient fatalities over two year period to draw conclusions.

2.0 BACKGROUND

The major portion of this report deals with the development of a Cause Identification Report for accidents involving canoes, kayaks, and inflatable craft. This section will discuss the work for canoes that preceded the initiation of the CIR project.

The recent success in developing a level flotation standard for outboard boats less than 20 ft. (6.1 m.) in length and in showing that that standard would significantly reduce the number of fatalities resulting from capsizing/swamping accidents within this class of boats led the Coast Guard to consider a flotation standard as an effective means of reducing the number of fatalities resulting from accidents involving canoes.

The Coast Guard initiated a task to evaluate an increase in canoe flotation as a means of reducing facilities, and if found to be effective, to formulate and evaluate candidate elements that could be used in a regulatory safety program. The first part of this task was to determine the potential benefit that could be obtained through an alteration in present canoe flotation practices. The methodology that was used to perform this task was adopted from a Coast Guard project relating to flotation in outboard boats. Coast Guard personnel had developed an evaluation form and coding instructions that were used to evaluate flotation as a potential safety enhancement concept in outboard boats (Reference 1). Figure 1 shows the evaluation form that was used for the initial canoe evaluation. Table 1, following the form, contains the instructions that the coders used in performing the evaluation.

While this canoe flotation evaluation task was underway, the USCG initiated a letter requesting information from canoe/kayak enthusiasts regarding their feelings about canoe/kayak safety and possible regulations affecting canoes and kayaks. This letter (shown in Table 2) was published in several canoeing magazines and the USCG received 77 responses to this letter. Table 3 summarizes responses that specifically answered the questions asked in the letter. Table 4 summarizes the serious responses to the letter. Some responses were of a "crack pot" nature and are not included.

---

[1] Effectiveness of a Proposed Level Flotation Standard by USCG Headquarters Marine Technology Department. Draft Report, 24 October 1975.

Based on these responses and other correspondence between Coast Guard personnel and canoe/kayak enthusiasts, the USCG decided to terminate the flotation evaluation for canoe accidents and broaden the project to include a comprehensive recovery failure Cause Identification Study. The remainder of this report documents the approach used and the results obtained for this Cause Identification Study. The program was also expanded to include analysis of accidents involving kayaks and inflatable craft as well as canoes.

CANOE FLOTATION EVALUATION FORM

Coders' names: 1 _____ 2 _____ 3 _____

State _____ Case No. _____ Date of Accident _____ Relevant Accident Yes ___ No ___

Hull Material	Engine Horsepower	Length	Persons On Board

Rented Boat	Manufacturer	Boat Age	Operator's Age

Accident Location _____ Water Condition _____ Operator Experience _____

Accident Type	Wind	Water Temperature	Air Temperature

Victim(s)		PFD worn	Level flotation questions						Would level flotation prevented fatality?		
Hours to Death	Age		1	2	3	4	5		1	2	3
							1	2			
(1)											
(2)											
(3)											
(4)											
(5)											

Remarks

FIGURE 1. CANOE FLOTATION EVALUATION FORM

TABLE 1. INSTRUCTIONS FOR
CANOE FLOTATION EVALUATION FORM

Relevant Accident: Skim read entire report, especially narrative. This study is being conducted to determine if the need exists to require a level flotation standard on canoes.

If the accident involves a situation where the canoe maintains its normal attitude, i.e., it does not capsize, flood with water, or sink to any degree then it would be considered irrelevant to the study and not checked.

It is important that this determination be made by reading the report, not by which type accident block has been checked on the BAR (Boating Accident Report).

Examples:

Relevant Accident -- Canoe sinks, floods, or capsizes regardless of how much additional information is available.

Irrelevant Accident -- Falls overboard - person falls out of boat, boat attitude remains normal.

Irrelevant Accident -- Two boats collide; one sinks but the other remains nearby, close enough to rescue people in water.

Irrelevant Accident -- No information available except that the person has disappeared.

Irrelevant Accident -- Non-fatal accidents.

Accident Location: Lake, river, rapids, below dam, etc.

Water Conditions: Calm, choppy, rough, very rough, strong current.

Type Accident: Flooding, capsizing, sinking.

TABLE 1. CONTINUED

"Level Flotation Questions"

1. Did victim lose contact with the boat? Initially.

   Example: Person in a canoe, stands up, loses his balance, he falls overboard, capsizing boat. He has to swim back to boat. This would be coded YES.

2. Did victim return to the boat?

   Note: This is only a relevant question if the person lost contact initially with the boat. Therefore, if you coded 2 or 9 for Question 1, code this a 9.

3. Did the victim leave the boat voluntarily?

   Note: This is not initially, as opposed to Question 1.

4. Did the boat sink?

5. Did the victim die of exposure? (Judgment) (Hypothermia)

   Note: If the person died within a couple of minutes of accident, hypothermia probably wasn't the cause.

   - Yes
   - No
   - Couldn't determine

Would level flotation have prevented the fatality?

What is the probability (your judgment) that a level flotation standard would have prevented the fatality?

- None
- Little or some
- Moderate
- High
- Couldn't determine

TABLE 1. CONCLUDED

Note: Prevented the fatality not the accident. Level flotation will not prevent the accident from occurring; it simply will mitigate the results by providing a level, stable platform.

Example: If a boat sinks, there certainly is at least some probability that the death may have been prevented.

Example: If the boat floods with two people on board, one person manages to cling to boat and survive, the other swims away and dies. Certainly this would not be a high probability situation.

TABLE 2. LETTER REQUESTING INFORMATION
ON CANOE/KAYAK SAFETY

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS
U.S. COAST GUARD (G-BBC-2)
400 SEVENTH STREET SW
WASHINGTON, D.C. 20590
PHONE: (202) 426-4027

5910/23-06

Dear Sir:

In the present boating regulations established by the Coast Guard, canoes were excepted from the Safe Loading, Safe Powering, and Flotation standards. The need for regulating canoes was not justified by accident data and boating statistics available when the regulations were being drafted. In 1973 the number of canoe accidents and the number of fatalities resulting from those accidents increased 51% and 59% respectively over the previous year. This substantial increase in accidents and fatalities warrants a closer look at the canoe accident problem.

The canoe accident can be broken down into two distinct phases. There is the avoidance phase which might be handled with a loading standard, or wearing of PFD's, analogous to a prevention concept. It incorporates all those items leading up to the time the accident occurs. The recovery phase concerns itself with the events following the accident, i.e., establishing a stable recovery platform for the victim; providing him with an opportunity to adequately bail the canoe.

Coast Guard research in the area of recreational canoeing indicates that the solution to the problem might be found in the recovery phase of an accident rather than the avoidance phase.

This does not mean the Coast Guard will ignore the avoidance phase of canoe accidents. Through continued research, efforts will be made to more fully define the avoidance problem. There may still be some area of the avoidance phase which may be controlled to the extent of reducing the number of accidents.

Presently, indications are that regulation of the avoidance phase, within practical limits, might not reduce the canoe accident rate. The design of a canoe to prevent accidents from occurring could result in a design not recognizable as a canoe. Because of the canoes inherent design and shape, and its intended usage, attempts to make it safe both dynamically and statically may be impracticable.

TABLE 2. CONTINUED

Canoes are easy to capsize but it does not seem fair to blame canoe hull design. The design does leave little room for user error during use, but it is basic to the popularity of canoes.

A review of the canoe accident data indicates less than 2% of the reported accidents were caused by overloading. Approximately, 67% of the canoes reported accidents had 1 or 2 persons in the canoe. Presently, this data appears to preclude the need for a loading standard for canoes.

None of the 1973 canoe accidents resulting in fatalities ~~were~~ not involved in overpowering. Only one of the 145 canoes in the reported accidents had a motor. At this point, a horsepower regulation for canoes does not appear justified.

In the majority of cases rescue was minutes away. The victims either had no PFD or were unable to rely on the canoe as a safe recovery platform. With no PFD and/or being unable to get back into the canoe the victims would tire and give up.

The basic flotation presently recommended by industry standards in canoes appears inadequate. The swamped canoe becomes neutrally buoyant about its ends and rolls like a log, thus tiring the victim who tries to get back in. Once in the canoe, the basic flotation is not always adequate to keep the gunwale above water. That condition can impair a victim's feeling of safety and may cause him to leave the canoe. (also he can't bail)

In conjunction with the level flotation project now in progress, the Coast Guard is looking into the application of level flotation to canoes. A level flotation standard might require the canoe to float level with its gunwales out of the water while supporting a specified percentage of the rated persons capacity.

Recent research in level flotation for canoes has given satisfactory results, such as righting a capsized canoe and entering it, while taking on very little water. This allows relative ease in bailing and a renewed feeling of safety. There is also a substantial increase in the feeling of safety when sitting in a swamped canoe that has level flotation, due to the buoyant forces of the flotation along the gunwales.

More research is required to find a fair and equitable ratio of flotation needed versus capacity, and how it is to be placed in the canoes. The amount of flotation and its placement in the canoe can have an adverse effect on the portability of a canoe, and also the available room in the canoe.

TABLE 2. CONCLUDED

The Coast Guard anticipates initiating first draft standards for canoes within a year. The approach to be taken or the exact requirements have yet to be determined through more research and investigation. There is a high probability of a level flotation requirement in a canoe standard.

The Coast Guard needs input from the canoe industry and public. The areas of conflict or topics to be considered generate many unanswered questions, some of which are listed below:

1) Do you feel there is a canoe accident problem? Why?

2) Do you think canoes should be regulated? Why?

3) With respect to question 2, if you answered "yes", under what considerations should they be regulated: powering, loading, level flotation? Why?

4) Do you think it's more important to avoid the canoe accident or be provided means to safely recover from the accident? Why?

5) With respect to question 4, are there canoe design parameters that could be changed to provide relief for the avoidance phase and/or the recoveryphase of an accident, and yet not remove the attractive characteristics of the canoe?

6) Do you feel the basic flotation recommended by industry standards is adequate with regards to the recovery phase of a canoe accident? Why?

7) What do you recommend as alternative means to alleviate the canoe accident problems?

8) While avoiding dictionary definitions and general terms, how would you define a canoe, with regards to the fine line where a square stern canoe becomes a rowboat?

Any response to these questions, and ideas and other information received from the canoe industry and public will be appreciated. We anticipate holding a seminar on canoe safety if the responses to this letter indicate that it would be helpful.

Sincerely,

R. H. BAETSEN
Captain, U. S. Coast Guard
Chief, Boating Standards Division
By direction of the Commandant

TABLE 3. SUMMARY OF ANSWERS
TO SAFETY RELATED QUESTIONS*

Question				
1.	Yes		No	Other
	22		27	1
2.	Yes		No	Other
	13		38	5
3.	Power	Load	Level Flotation	Other
	5	7	8	4
4.	Avoid		Recover	Both
	26		7	8
5.	Remove seats		1	
	None		12	
	Add flotation		5	
	Remove sharp edges, etc.		2	
	Change for particular use (identify properly)		2	
6.	Yes		No	Other
	15		6	9
7.	Aid canoe organizations		4	
	Warning signs		6	
	Safety instruction Education, Training		46	
	Require PFD's (encourage)		14	
	Labels on canoes		3	
	Paddler certification		2	
	Canoe registration		1	
8.	Several very general description type definitions received. Appeared not to warrant summarizing.			

* See list of questions on last page of Table 2.

TABLE 4. SUMMARY STATEMENTS OF LETTERS

1.	There is no canoe problem (or like skiing, etc.)
2.	Does not injure anybody else so no regulation needed.
3.	Canoe capsizing is a common event and is expected.
4.	Education is the answer, not regulation.
5.	Must know the dangers ahead - use signs at put-ins.
6.	Use PFD's, not necessarily USCG Approved.
7.	Follow the Safety Code of the AWA (American Whitewater Association).
8.	Might consider registration.
9.	Changes to canoes might make them more dangerous.
10.	Set minimum standards for canoe construction and manufacturing.
11.	Regular boat rules cannot be used for canoes.
12.	In heavy whitewater could use more flotation to protect canoe.
13.	Cannot have one standard for all canoes.
14.	Could use regulation for equal flotation at both ends.
15.	Regulation could be used for load capacity.
16.	Consider a Canoe Auxiliary similar to Power Squadron or C. G. Auxiliary or expand and support Red Cross Instruction.
17.	Canoes are not toys and should be taken seriously.
18.	Canoes are designed to horse around in and are usually used in shallow or protected waters.
19.	Flotation should be standardized.
20.	Accident problem is due to "innocent canoeist", not the same as "inexperienced."
21.	USCG films or other media should show the grim side also, in addition to the glamorous slalom runs.
22.	Problem is with people, not the canoe.
23.	Basic flotation standard is not adequate, so level flotation maybe should be considered, but keep weight down (woman) for easier portage.
24.	Most people are not interested in "safety" because they don't know how much they don't know.
25.	Just make sure canoe floats after being upset.
26.	BIA standard is adequate but less than half of manufacturers meet these standards.
27.	Make distinction between river canoes and lake canoes.
28.	Need education, instruction, and training.
29.	Liveries should assume (encouraged or required) some of the responsibility on enforcing safety rules.
30.	Flotation devices (PFD's) do not help a boater if he does not wear it (such as a seat cushion).
31.	Some want wearing PFD mandatory while others contend in some cases PFD would be detrimental.
32.	Make PFD's required for rentals and certain waterways.
33.	Give voluntary guidelines a chance before imposing any mandatory regulations.
34.	USCG should decertify all Type II PFD's.

TABLE 4. CONTINUED

35.	It is USCG's job to properly inform the public and not to mandate design changes.
36.	Paddler feedback is important but manufacturers do not listen now. They might if USCG became involved such as by a Canoe Safety Board to consider comments and/or defects. CG should emphasize safety and either start their own instruction classes or promote and back up organizations that already have courses and expand on them. Uniform/minimum instruction requirements could be established.
37.	Why not approve inflatable PFDs for canoes?
38.	Should legislate the projecting keel off the canoes as does nothing for you in lakes and is negative factor in rivers. People who paddle flat water do not have any real feel for their equipment. The private inflatable raft figures in many accidents. Class IV ring buoy or cushion should not be acceptable for canoes. Class II PFD's should be taken off the market. USCG should get in and mix it up with the clubs and organizations that are already involved.
39.	To increase stability, do away with seats, at least the rear seat. Do not use flotation air tanks without a filler as leakage could be a problem. More flotation might be helpful if many fatalities occur far from shore in relatively calm, warm water. Paddlers sitting happily in a flooded but stable canoe may prove to be a myth. Maybe could provide some financial support to canoe organizations (such as advertising of courses, etc.), or provide warning signs for posting at put-in spots, or safety decals on canoes, or safety instruction sheets for dealers and liveries.
40.	"Safe recovery platform" concept has no place in fastwater. USCG must be careful not to regulate additional fatalities into the canoe scene. Cannot conceive of climbing into a canoe filled with water even with gunwhales clear. One of the most important characteristics of a canoe is "emotion."
41.	Should not be allowed to rent a canoe unless you rent a PFD also or show proof that you already have one. All boaters should wear a PFD but would be difficult to enforce such a law.
42.	Put a warning label on all canoes such as on a pack of cigarettes.
43.	Hypothermia is really the killer. Level flotation standards are not required. Techniques for holding onto a canoe are instinctive and do not need to be learned. People let go for only two reasons, hypothermia and swimming to shore. Effects of cold water is the most neglected aspect of education. Canoes should be regulated if it can be shown such would reduce accidents and not unduly restrict canoeing. The idea of a canoe safety seminar seems excellent.
44.	Addition of flotation would facilitate a safe rescue in whitewater. Industry standards are not adequate. Some canoes are not able to withstand whitewater boating but this seldom results in a life-threatening situation.
45.	The present day canoe should be regulated to assure adequate flotation. Also, as far as power and loading. Should contact large users of canoes for more data.
46.	Not all manufacturers use BIA standards, so this should be regulated in a limited way. Exterior or hull design should not be regulated. Consumers should be furnished with realistic data on canoes (load, power, etc.).

TABLE 4. CONCLUDED

47.	A.W.A. — Just what the name implies A.C.A. — competitive paddling in International Canoe Federation type Olympic flat water shells and I.C.F. enclosed whitewater kayaks and canoes U.S.C.A — competition in open pleasure or cruising canoes and canoe trips both on flatwater and whitewater Above are primary interests and jurisdiction.
48.	You could fill a canoe with flotation and it would still roll like a log.
49.	The A.W.A. has undertaken the task of collecting accident data and has developed a form (questionnaire).
50.	There should be regulations except in cases for racing or highly trained individuals, where a waiver for the original purchaser would be required.
51.	People should be allowed to use any canoe as long as they are aware it does not meet certain standards, except children.
52.	A comprehensive program should include: 1) paddling, swimming, first aid, and rescue techniques training; 2) a standardized and recognizable method of marking rivers as to hazard level; and 3) a certification program for paddlers.
53.	PFD regulations should be changed to encourage wearing PFD's, approved or not. Open boat flotation could be improved without affecting capacity.

3.0 SCOPE OF THE PROBLEM

In order to get an indication of the potential benefit that could be attained through a regulatory safety program, a look at the scope of the problem is in order. Pertinent data for kayaks and inflatable craft were not available for this evaluation because specific categories for these craft are not presented in CG-357 or the NBS; therefore, this scope was evaluated for canoes only.

It would be desirable to compare the fatality rate for canoes with the fatality rate for the class of boats that will be required to have level flotation after July 1978. Looking at Table 5, which is taken from the Nationwide Boating Survey (Reference 2) in 1973, the fatality rates for different boat types can be seen.

TABLE 5. FATALITIES PER 100,000 BOATS BY TYPE

BOAT TYPE	FATALITIES	FATALITIES PER 100,000 BOATS
CANOE (NO MOTOR)	170	38.8
CANOE (MOTOR)	4	7.0
HOUSEBOAT	3	7.8
INBOARD	123	21.9
INBOARD/OUTBOARD	44	8.3
OUTBOARD [1/]	939	21.2
ROWBOAT/JOHNBOAT (NO MOTOR)	178	21.1
ROWBOAT/JOHNBOAT [1/] (MOTOR)	56	14.7
SAILBOAT (NO AUX.)	53	12.1
SAILBOAT (AUX.)	25	29.4
OTHER	159	29.1
TOTAL	1,754	21.0

[1/] Because the questionnaire did not define outboard to exclude rowboats and johnboats, an indeterminate number of motorized rowboats and johnboats may be included in the outboard figures.

[2] Wulfsberg, Rolf M. and Darryl A. Lang, Recreational Boating in the Continental United States in 1973: The Nationwide Boating Survey, USCG Final Report. October 1974. NTIS #AD-A000 471.

Using population data from NBS, the canoe (no motor) and canoe (motor) fatality rates can be combined to obtain an overall fatality rate as shown in the following table.

BOAT TYPE	NUMBER OF BOATS	FATALITIES/ 100K BOATS
CANOE (NO MOTOR)	438,550	38.8
CANOE (MOTOR)	56,985	7.0
CANOE (ALL)	495,535	35.1

Using the data in Table 5 and population data from NBS, the fatality rate for the class of boats that will be affected by the level flotation standard can be approximated as shown in the following table.

BOAT TYPE	NUMBER OF BOATS	FATALITIES/100K
OUTBOARD	4,420,006	21.2
ROWBOAT/JOHNBOAT (NO MOTOR)	841,773	21.1
ROWBOAT/JOHNBOAT (MOTOR)	380,661	14.7
"LEVEL FLOTATION AFFECTED BOAT"	5,642,440	20.7

This fatality rate is only approximate in that the category "outboard" contains boats which are not affected by the level flotation standard, i.e., boats over 20 ft. in length; however, at this stage of the research it is felt that this approximation is adequate.

Using these fatality rates, it can be seen that the fatality rate for canoes based on the number of fatalities per boat in existance is 1.7 times as great as the fatality rate for "level flotation affected boats."

Other useful comparisons would be a ratio of the fatality rates based on passenger hours and boat hours. The following tables show this analysis using data from NBS.

BOAT TYPE	NUMBER OF FATALITIES	NUMBER OF PASSENGER HRS	FATALITIES/ PASSENGER HRS $X10^7$
CANOE (NO MOTOR)	170	102,678,809	
CANOE (MOTOR)	4	28,497,775	
CANOE (ALL)	174	131,176,584	13.26
OUTBOARD	939	1,719,439,174	
ROWBOAT/JOHNBOAT (NO MOTOR)	178	128,474,927	
ROWBOAT/JOHNBOAT (MOTOR)	56	84,561,968	
"LEVEL FLOTATION AFFECTED BOAT"	1173	1,932,476,069	6.07

BOAT TYPE	NUMBER OF FATALITIES	NUMBER OF BOAT HRS	FATALITIES/ BOAT HRS $X10^7$
CANOE (NO MOTOR)	170	49,476,346	
CANOE (MOTOR)	4	10,521,958	
CANOE (ALL)	174	59,998,304	29.0
OUTBOARD	939	614,174,260	
ROWBOAT/JOHNBOAT (NO MOTOR)	178	54,122,769	
ROWBOAT/JOHNBOAT (MOTOR)	56	34,561,211	
"LEVEL FLOTATION AFFECTED BOAT"	1173	702,858,240	16.7

From these three evaluations it can be seen that the fatality rate for canoes is 1.7 to 2.2 times as great as the fatality rate for "level flotation affected boats," depending on the type of exposure data used. These fatality rates indicate that a need does exist for further evaluation of canoe related fatalities.

4.0 DATA SOURCE/ACQUISITION

A major effort of this task was in the acquisition and manipulation of data that was to be used in the analysis. A sample of accidents was selected, methodology for classifying the data was developed, and accident data was coded. The following subsections describe the data base that was used for evaluation, present its limitations, and discuss the procedures developed and used for coding the accident data into a more usable form.

4.1 Data Base Utilized

Accident data reviewed was provided by USCG personnel. To obtain a representative data base, multiple year data was used (1973 and 1975). All accident data that Coast Guard Headquarters receives is coded and stored in a computer file. Accident data with specific requirements may be obtained from this stored data by having the computer sort by the desired variables. The data that the Coast Guard wanted reviewed consisted of accidents resulting in fatalities involving canoes, kayaks, and inflatable craft. USCG personnel obtained a listing of accident data for the classifications of boat types and years as shown in the following table.

ACCIDENT DATA SELECTED

1973	1975
Code 6 -- Canoe -- includes "dug-outs" but not kayaks)	Code 6 -- Canoes and Kayaks
Code 7 -- Other -- includes kayaks and inflatables	Code 7 -- Inflatables

Since there was no separate code for kayaks and inflatables in 1973, accidents involving these types of craft had to be screened from all accidents coded as OTHER. This screening of data was done by USCG personnel who then provided Wyle access to the complete accident file for all selected accidents. Since this project was concerned with recreational boating safety, commercial vessels, such as tour boats, and non-boats, such as inner tube devices and barrel rafts (that had been coded in the above mentioned categories), were also excluded from the data base.

The data which was utilized is presented in Table 6, by year and type of craft.

TABLE 6. ACCIDENTS REVIEWED FOR ANALYSIS

1973		1975	
CANOES:		CANOES:	
No. Accidents	92	No. Accidents	103
No. Occupants	223	No. Occupants	232
No. Fatalities	111	No. Fatalities	115
KAYAKS:		KAYAKS:	
No. Accidents	6	No. Accidents	11
No. Occupants	11	No. Occupants	15
No. Fatalities	6	No. Fatalities	12
INFLATABLE CRAFT:		INFLATABLE CRAFT:	
No. Accidents	39	No. Accidents	36
No. Occupants	96	No. Occupants	94
No. Fatalities	44	No. Fatalities	42

4.2 Data Limitations

In order to adequately assess existing conditions and formulate programs to rectify problem areas and develop guidelines for safety programs, information on the whole boater population, including those not involved in accidents, those having non-fatal accidents, and those involved in fatal accidents is required. This type of information is simply not available at the present time. It should be noted that:

- Few non-fatal canoe accidents qualify as reportable accidents, as they generally do not result in over $100 damage or injuries causing incapacitation for 72 hrs.
- Experience indicates that the reporting rate for non-fatal boating accidents that do meet the reportable accident criteria is no more than 3% to 10%.

For these reasons, fatal accident data alone was used in this study. It is important to make clear the limitations which this imposes on the resulting analysis. Without data on the characteristics of the canoeist population as a whole (e.g.,

what percent have taken a boating safety course), we cannot establish rates of occurrence of particular events relating to fatal accidents. This is particularly important as accident rate data is critical in assessing the effectiveness of existing safety programs or devices. For example, a comparison between the fatality rate for canoeists having or not having formal instruction would indicate whether or not existing formal instruction provides significant safety benefits. In order to establish potential benefits, it is necessary to have a measure of general exposure, as well as data relating to fatal accidents. Without this information, it is impossible to calculate probability of recovery for given conditions.

In addition, on a per person or boat basis, rate data can provide information on the benefit of various safety measures. As compliance costs for large safety programs are usually incurred on a per person or boat basis, a program which generates a large change in a particular accident rate will generally have more potential for promulgation than one having a smaller rate change. Rates (or risks) are not the whole answer, however, as any safety program must have a significant absolute benefit (i.e., save at least "X" lives) in order for it to be worth the fixed costs associated with promulgation. In determining absolute possible benefits, fatal accident data analysis such as used in this effort can provide significant information. The information can be valuable only <u>if the performance characteristics of the regulatory alternative(s) under consideration are known</u>. The latter point is important:

- From fatal accident analysis the range of absolute possible benefits which would accrue if, say, boats changed such that they always floated level, or people were changed such that they never swam to shore from a capsized boat.
- We <u>cannot</u> determine from fatal accident data the probability that a "50-25 level flotation" boat will float level, nor can we assess the effect of formal education on the probability that a victim will attempt to swim to shore. Both of these require exposure data to establish the probabilities; fatal accident data by itself cannot establish probabilities.

In addition, there is a good deal of information missing in the fatal accident cases which were actually used for the present analysis, as will be described in

the following section. It must be kept in mind, then, that the statistical results of the present analysis are certainly biased, and should be considered only as rough estimates, to be used as directional guidelines.

4.3 Data Used Compared to Data Base Available

In order to determine if the data base used was representative of the actual accident situation, a comparison between the base used and the total data available needed to be made. The total number of fatalities reviewed for canoe accidents in 1975 was 115. Boating statistics for 1975 as published in CG-357 indicated that there were 152 fatalities (this 152 includes kayak fatalities). If the number of kayak fatalities that was reviewed is added to the 115 canoe fatalities reviewed for 1975, a total of 127 fatalities is obtained. The files at USCG Headquarters were revisited, and the majority of the missing files were accounted for. As the coding of the accidents had been completed when the remaining accident files were located, the decision was made that there was no need to code the additional accidents. It was felt that a sample of 127 out of 152 total was sufficiently representative for analysis.

Statistics for kayaks and inflatables are not published as separate categories in CG-357, so a comparison of this data cannot be made. A study of Inflatable Boat Accidents for 1969-1973 prepared by Ensign D. P. Fortune, USCGR, lists the number of fatalities resulting from inflatable boats as 45 for 1973. The sample that was used in this analysis contained 44 fatalities. In looking at the earlier study, it was found that rafts made from inner tubes were included as inflatables; in this study, they were not. This could account for the discrepancy in the number of fatalities. It was felt that the sample used in this study was representative of the data available, and there was no need to evaluate every fatality.

In addition to the difficulty in locating the accident files, there were many deficiencies regarding the files themselves. Some of the files consisted only of a newspaper clipping discussing the accident; there was no BAR (Boating Accident Report) or MIO (Coast Guard Marine Inspection Office) report. In many cases, the BAR was not filled out completely. Part of the cause in the lack of required information was the fact that we were looking for information that is not specified in the BAR format and could only be obtained through a detailed and complete narrative description of the accident, which was not provided in many cases.

Tables 7, 8, and 9 list each variable coded and the percentage of the cases reviewed in which that particular variable was unknown. As can be seen from the tables, in many instances, there is a very large number of unknowns. The tables list information for fatalities only. If unknowns for all occupants were examined, it would be found that the percentage of unknowns would generally be larger. This is because the BAR forms and MIO reports generally contain more information on accident fatalities than survivors.

In treating the data coded "unknown", it was assumed that the unknowns are distributed the same as the known data. While this assumption is questionable in light of the extensive number of unknown responses to many questions, it is the only assumption available if any direction is to be gained from the present data.

4.4 Data Coding Procedures

Once the data base had been selected, the next step was to develop a format which would enable the researchers to extract and categorize useful information. Table 7 contains a list of the accident variables that were coded for each accident. Appendix A contains the coding instructions that were used by the accident coders when reviewing the accident files. These instructions were drafted at the beginning of this project, reviewed by personnel at Wyle and USCG Headquarters, and revised as needed. As the coding proceeded, it was found that several changes in the coding procedure were necessary due to the nature of the accident data. In most instances, previously coded data was updated to fit the new instructions. Late in the coding, two variables were added, (#45: Number of boats involved, and #46: Contributing Factors), which were coded only for the remaining accidents.

Many of the variables used required a somewhat subjective evaluation of the information in the accident file. In order to minimize individual biases, two or more coders assessed each accident as follows: After one coder had coded an accident, the coded information and the accident file were given to a second coder, who made an independent assessment and noted any differences of opinion between the two. Any discrepancies were discussed, and in cases where mutual agreement could not be reached, a third coder was used to arbitrate the decision.

TABLE 7. UNKNOWN DATA FOR CANOE FATALITIES

Percent Unknown	Variable	Percent Unknown	Variable
0	STATE	52	DISTANCE FROM SHORE
0	MONTH	22	WIND
0	YEAR	15	WATER CONDITIONS
12	TIME OF DAY	27	WATER TEMPERATURE
8	ACCIDENT TYPE	43	AIR TEMPERATURE
0	BOAT TYPE	68	TIME OUT BEFORE ACCIDENT
0	PERSONS ON BOARD	45	CAUSE OF ACCIDENT
6	OCCUPANT'S AGE	55	FINAL BOAT CONFIGURATION
0	OCCUPANT'S SEX	0	OCCUPANT'S BEHAVIOR*
73	FORMAL BOATING INSTRUCTION - GENERAL	15	PFDS ON BOARD
73	FORMAL BOATING INSTRUCTION - CANOE	21	PFD AVAILABILITY/USE
24	RENTED BOAT	6	TIME 'TIL PFD DONNED/REMOVED
39	HOMEMADE BOAT	15	PFD TYPE
25	BOAT LENGTH	17	PFD MALFUNCTION
17	BOAT MATERIAL	13	IMPROPER PFD USE
14	HORSEPOWER ON BOARD	31	VICTIM'S CONDITION
2	PARTICIPATING IN CONTEST	0	HEALTH **
75	OCCUPANT'S BOATING EXPERIENCE - TOTAL	41	TIME FROM ACCIDENT TO DROWNING
76	OCCUPANT'S BOATING EXPERIENCE - CANOE	34	DISTRESS NOTIFICATION
1	BODY OF WATER	0	ALCOHOL **
4	TYPE OF WATER		

*In many cases, details of occupants behavior are not known, and in this table the 0% unknown in many cases merely indicates that the final outcome (fatality or survivor) of the occupant is known.

**Health was assumed good and alcohol not involved, unless it was positively stated to the contrary in the case report.

TABLE 8. UNKNOWN DATA FOR INFLATABLE FATALITIES

Percent Unknown	Variable	Percent Unknown	Variable
0	STATE	54	DISTANCE FROM SHORE
0	MONTH	36	WIND
0	YEAR	16	WATER CONDITIONS
19	TIME OF DAY	46	WATER TEMPERATURE
7	ACCIDENT TYPE	52	AIR TEMPERATURE
0	BOAT TYPE	64	TIME OUT BEFORE ACCIDENT
0	PERSONS ON BOARD	48	CAUSE OF ACCIDENT
5	OCCUPANT'S AGE	43	FINAL BOAT CONFIGURATION
1	OCCUPANT'S SEX	0	OCCUPANT'S BEHAVIOR*
73	FORMAL BOATING INSTRUCTION - GENERAL	27	PFDS ON BOARD
73	FORMAL BOATING INSTRUCTION - INFLATABLE	22	PFD AVAILABILITY/USE
22	RENTED BOAT	1	TIME 'TIL PFD DONNED/REMOVED
1	HOMEMADE BOAT	26	PFD TYPE
56	BOAT LENGTH	19	PFD MALFUNCTION
1	BOAT MATERIAL	13	IMPROPER PFD USE
13	HORSEPOWER ON BOARD	31	VICTIM'S CONDITION
0	PARTICIPATING IN CONTEST	0	HEALTH
85	OCCUPANT'S BOATING EXPERIENCE - TOTAL	55	TIME FROM ACCIDENT TO DROWNING
85	OCCUPANT'S BOATING EXPERIENCE - INFLATABLE	43	DISTRESS NOTIFICATION
0	BODY OF WATER	0	ALCOHOL
0	TYPE OF WATER		

*In many cases, details of occupants behavior are not known, and in this table the 0% unknown in many cases merely indicates that the final outcome (fatality or survivor) of the occupant is known.

**Health was assumed good and alcohol not involved, unless it was positively stated to the contrary in the case report.

TABLE 9. UNKNOWN DATA FOR KAYAK FATALITIES

Percent Unknown	Variable	Percent Unknown	Variable
0	STATE	33	DISTANCE FROM SHORE
0	MONTH	22	WIND
0	YEAR	28	WATER CONDITIONS
6	TIME OF DAY	22	WATER TEMPERATURE
6	ACCIDENT TYPE	33	AIR TEMPERATURE
0	BOAT TYPE	89	TIME OUT BEFORE ACCIDENT
0	PERSONS ON BOARD	72	CAUSE OF ACCIDENT
0	OCCUPANT'S AGE	61	FINAL BOAT CONFIGURATION
0	OCCUPANT'S SEX	0	OCCUPANT'S BEHAVIOR*
72	FORMAL BOATING INSTRUCTION - GENERAL	11	PFDS ON BOARD
72	FORMAL BOATING INSTRUCTION - KAYAK	11	PFD AVAILABILITY/USE
28	RENTED BOAT	0	TIME 'TIL PFD DONNED/REMOVED
33	HOMEMADE BOAT	11	PFD TYPE
28	BOAT LENGTH	11	PFD MALFUNCTION
11	BOAT MATERIAL	11	IMPROPER PFD USE
0	HORSEPOWER ON BOARD	22	VICTIM'S CONDITION
0	PARTICIPATING IN CONTEST	0	HEALTH
78	OCCUPANT'S BOATING EXPERIENCE - TOTAL	28	TIME FROM ACCIDENT TO DROWNING
78	OCCUPANT'S BOATING EXPERIENCE - KAYAK	22	DISTRESS NOTIFICATION
0	BODY OF WATER	0	ALCOHOL
0	TYPE OF WATER		

*In many cases, details of occupants behavior are not known, and in this table the 0% unknown in many cases merely indicates that the final outcome (fatality or survivor) of the occupant is known.

**Health was assumed good and alcohol not involved, unless it was positively stated to the contrary in the case report.

This coded data, from over 280 accidents involving over 670 occupants, was then keypunched, and a scan sheet of the punched data was obtained. This was scanned for gross errors, such as transposed columns of data and missing data. A sample of accident files was then selected, reviewed, and compared with the data that was stored on the computer. In a sample of 40 accident files, there were no errors found in the coded data. This data was now ready to be manipulated and analyzed as discussed in the following sections.

5.0 DATA MANIPULATION/ANALYSIS METHODS

Two general types of data analysis methods were used, statistical comparisons and engineering evaluation of raw data. Statistical comparisons of independent variables were conducted to determine if correlations between the various occurrences existed. Since the data base consists of accidents containing at least one fatality, it cannot be considered as representative of the canoe/kayak/inflatable boating population in general. For this reason, generalizing the results of the statistical analyses to the entire population cannot be recommended.

The evaluation that is of more practical use for present purposes is the evaluation of the raw coded data. From this data, predominant characteristics of accidents that result in fatalities can be identified and areas for potential safety enhancement programs can be indicated.

In order to quantify the benefit of a safety enhancement program, further analysis of the boating population would be required. Analysis of the fatal accidents does not indicate what the results of a safety program would be. However, it does indicate the problem areas, quantify the maximum potential of a program, and identify the population that is in need of the safety program(s).

As can be seen from Table 6, the total number of accidents used for this analysis was 287, the number of boat occupants was 671 and 330 of these occupants were fatalities. For each of these occupants, there was coded data for over 40 variables with some variables containing over 60 possible categories. The next step was to arrange all of this data into a simplified and meaningful format so that it could be more easily evaluated. In general, the data was grouped into profile elements; i.e., by characteristics of the craft, occupant, environment, and accident dynamics. Three craft categories were used because it is felt that peculiarities of each type of craft's construction and use would warrant an independent analysis of the pertinent accident data. Data for separate years was reviewed for each craft and descriptive profile to determine if any trends in accident scenarios were present.

Six descriptive profiles were chosen to describe each accident and occupant. All related variables that describe a particular facet of the accident are grouped together under a heading or a profile of the particular facet they describe. Table 10 lists each profile heading and the variables that make up that profile. Each element is presented as frequency of occurrence for each category of the variable. The initial data profiles that comprise the matrix of Figure 2 are contained in Appendix B, with the two years being combined. From studying this data and using engineering judgment and expertise that had been gained over several years of working with the Recreational Boating Safety Program, cross sorts (Appendix C) of variables and evaluation of data was conducted as discussed in the following sections.

TABLE 10. ELEMENTS OF DESCRIPTIVE PROFILES

DESCRIPTIVE PROFILE	PROFILE ELEMENTS
BOAT	- BOAT TYPE
	- RENTED BOAT
	- HOMEMADE BOAT
	- BOAT LENGTH
	- BOAT MATERIAL
	- HORSEPOWER ON BOARD
OCCUPANT	- OCCUPANT'S AGE
	- OCCUPANT'S SEX
	- FORMAL BOATING INSTRUCTION - GENERAL
	- FORMAL BOATING INSTRUCTION - SPECIFIC
	- OCCUPANT'S BOATING EXPERIENCE - TOTAL
	- OCCUPANT'S BOATING EXPERIENCE - SPECIFIC
	- HEALTH
ENVIRONMENT	- STATE
	- MONTH
	- YEAR
	- TIME OF DAY
	- BODY OF WATER
	- TYPE OF WATER
	- DISTANCE FROM SHORE
	- WIND
	- WATER CONDITIONS
	- WATER TEMPERATURE
	- AIR TEMPERATURE

TABLE 10. CONCLUDED

DESCRIPTIVE PROFILE	PROFILE ELEMENTS
PRE-ACCIDENT OPERATION	- PERSONS ON BOARD - PFDS ON BOARD - PFD TYPE - PARTICIPATING IN CONTEST - TIME OUT BEFORE ACCIDENT - ALCOHOL - NO. BOATS INVOLVED - CONTRIBUTING FACTORS
ACCIDENT INITIATOR	- ACCIDENT TYPE - CAUSE OF ACCIDENT
POST-ACCIDENT OPERATION	- FINAL BOAT CONFIGURATION - OCCUPANTS' BEHAVIOR - PFD AVAILABILITY/USE - TIME UNTIL PFD DONNED/REMOVED - PFD MALFUNCTION - IMPROPER PFD USE - VICTIMS' CONDITION - TIME FROM ACCIDENT TO DROWNING/RESCUE - DISTRESS NOTIFICATION

DESCRIPTIVE PROFILES

BOAT

OCCUPANT

ENVIRONMENT

PRE-ACCIDENT OPERATION

ACCIDENT INITIATOR

POST-ACCIDENT OPERATION

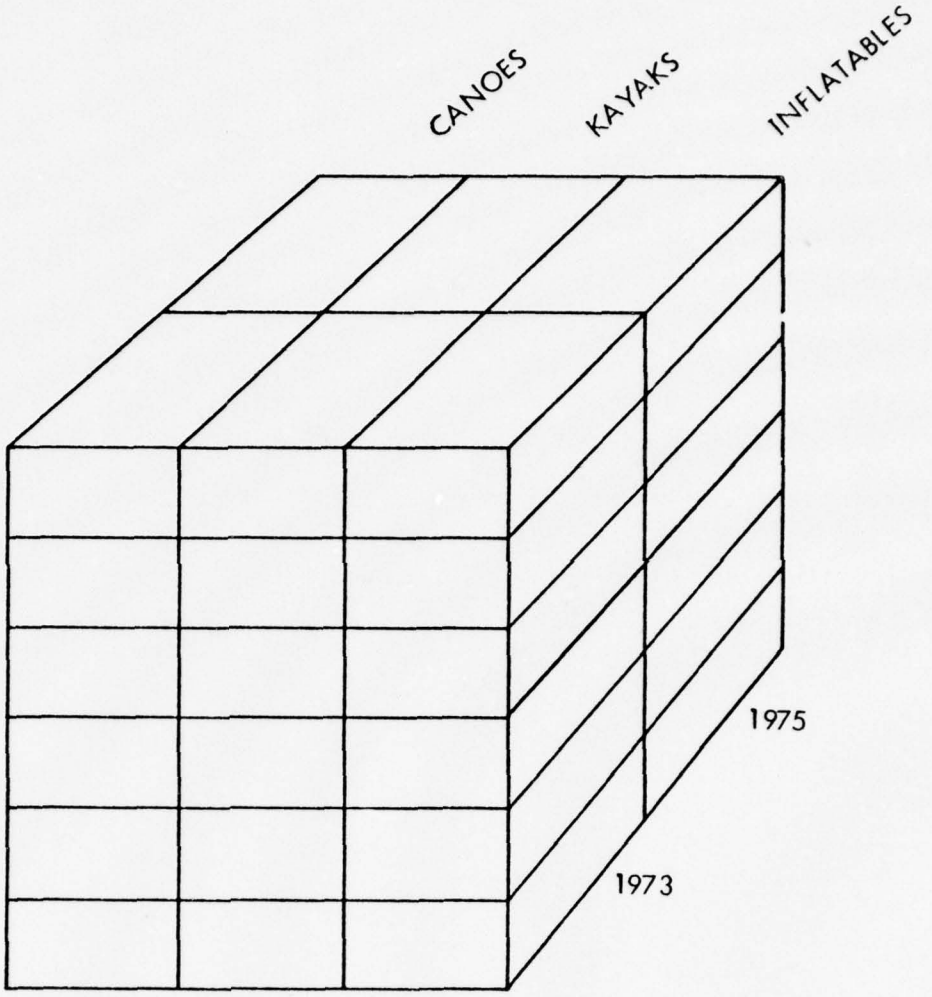


FIGURE 2. DATA CATEGORIZATION

6.0 DATA EVALUATION - CANOES

The manner in which the data was coded and stored can be used to generate a variety of information. The basic information that can be obtained is the number of fatalities for a given category of a specified variable. From this, percentage of total fatalities can be calculated. In a previous project, an Accident Recovery Model (ARM) was developed (Reference 3). Much of the procedure for the present evaluation was based on this previous work. A significant output from the ARM was the probability of recovery, which cannot be obtained from the present data which involves fatalities only and, therefore, is biased. What is felt to be a more significant output from this study are the number of fatalities and the percentage of total fatalities for a given condition. This information can be used to identify problem areas toward which further research should be aimed.

Over 40 variables were coded containing multiple categories of conditions. In order to address the questions which this report is concerned with, an approach combining logical analysis and scanning of the data was used to determine the relevant combination of variables that were to be studied in more detail. Areas of potential alternate safety measures that will be discussed include boater education, evaluation of PFD carriage/use requirements (both new requirements and enforcement of present regulations), and provision of a safety recovery platform through the use of vessel flotation.

6.1 Education Alternatives

Education can be considered to be of two forms: instruction, where the boater learns principally in a classroom; and experience, through actual boating activities. While each has its advantages, a combination of both probably provides optimal benefits.

Looking back at Table 7, it can be seen that from the data base reviewed, there was not much information available on the education levels of persons dying as a result of a canoe accident. In 73% of the fatal cases reviewed, education was unknown for both general and canoe-related formal boating instruction. For boating experience the percentages of unknown are 75% for general experience and 76% for canoe experience. Therefore, only approximately 25% of the fatalities that were reviewed are being used in the following analysis.

---

[3] Doll, T., et al, Personal Flotation Devices Research - Phase I, Final Report to USCG. Contract DOT-CG-42333-A. July 1976.

Figures 3 and 5 show the distribution of fatalities by boating experience, for both canoe and general experience, which can be considered a measure of education. The figures show that most of the fatalities for which victim experience is known involve people that have little boating experience. Table 11 shows the distribution of fatalities by formal boating instruction and by sex. It indicates that persons involved in canoe fatalities whose educational background is known have not generally taken a formal boating course. This data shows that canoe fatalities generally involve inexperienced and uninstructed persons.

The education level of the survivors of these accidents should be examined next. Figures 4 and 6 and Table 12 present boating experience and occupant sex data for those who survived in the accidents reviewed. It should be remembered that this data is not for the general canoeing population but is only for occupants who were involved in an accident in which at least one person died.

Looking at the known data in Figures 4 and 6 and Table 12, it can again be seen that many of the survivors had little boating experience and few had taken a boating safety course. Summarizing formal canoe instruction for fatality and survivors, the following table is obtained.

	FATALITIES	SURVIVORS
HAD CANOE INSTRUCTION	5	18
DID NOT HAVE CANOE INSTRUCTION	56	39

For this data $\chi^2 = 8.83$ which is significant at a confidence level of over 99%.

Occupant education appears to be closely related to the outcome of an accident, but again the limitation of the data as discussed in Section 4.2 must be considered. An important aspect of this data is the fact that it presents an initial look at some of the elements that make up the profile of the occupants that are involved in fatal canoe accidents. These people are generally inexperienced and have not had a formal boating course. Tables 11 and 12 show that a majority of these occupants are male, and Figures 7 and 8 show the age distribution of these people. Although data is not available to compare the people that were involved in fatal canoe accidents in 1973 and 1975 with the general canoe population or the canoe population that is involved in nonfatal accidents, the data that is available shows the segment of the population that should be reached if an educational program is considered as a safety enhancement program. With the data available, it cannot be

determined if education is the most effective method of preventing fatalities; what the data does show is the population that would need to be reached with such a program.

Table 11 shows that for the known data, 5 out of 61 fatalities or 8.2% have had formal boating instruction. Table 47 in the NBS shows that in the Continental United States 25.7% of the primary operators of boats have had formal boating instruction. Looking at these figures, it appears that the education level of canoe fatalities is well below that of the primary operator population. It must be remembered, however, that there were 73% unknowns in the canoe fatality sample which may have an influence on the results. The numbers from NBS are for the primary operators and not the boating public in general.

Figure 9 indicates that it is not the novice that rents a canoe that gets in trouble, but the novice that buys or borrows one. Although safety programs for rental liveries are important, they apparently should not overshadow the private ownership market which accounts for a majority of the fatalities. At this point, the relative fatality rate between owned and rented canoes is not known; only the total number of fatalities from each group is known.

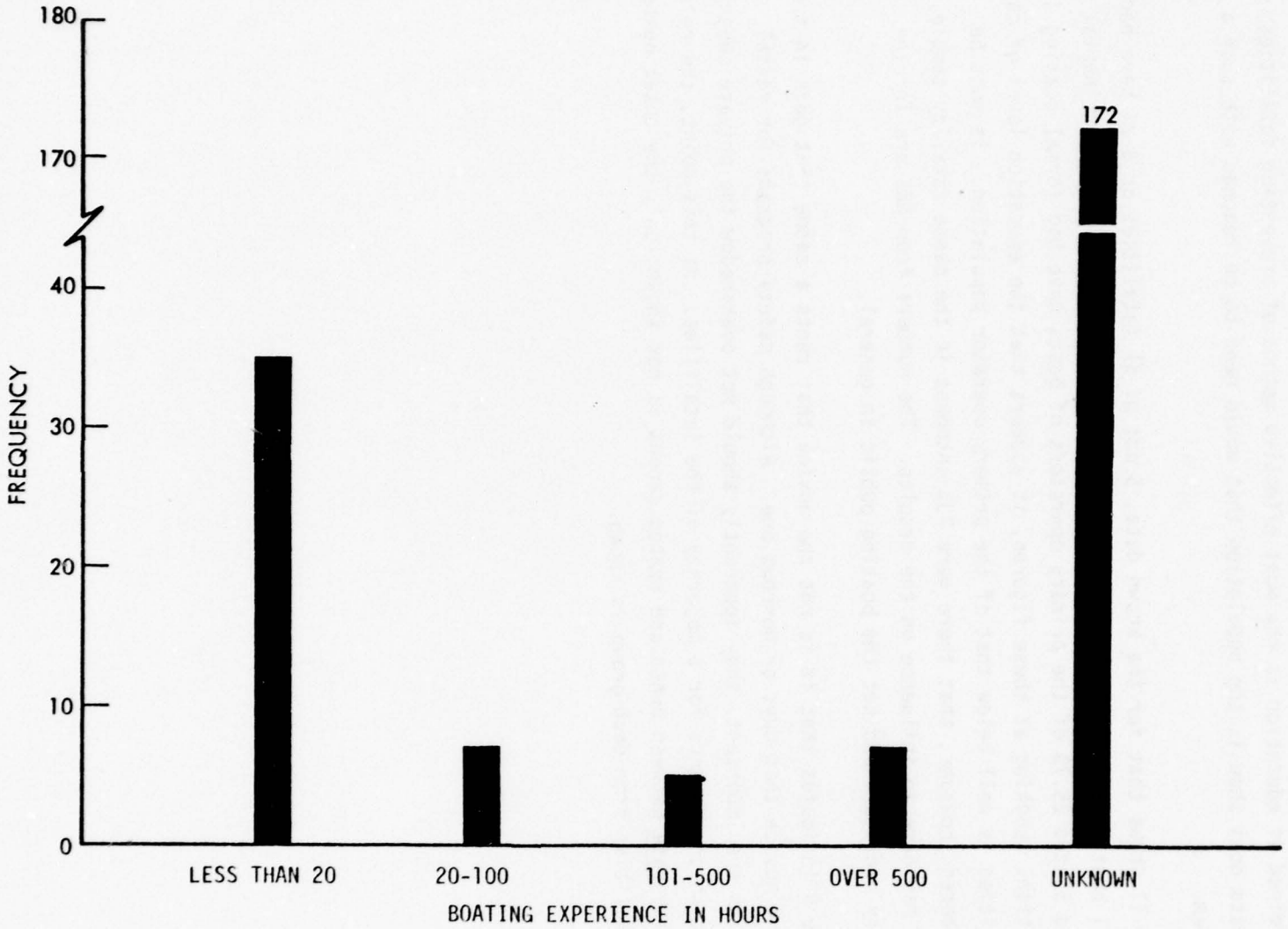


FIGURE 3. DISTRIBUTION OF NUMBER OF CANOE FATALITIES BY CANOE BOATING EXPERIENCE

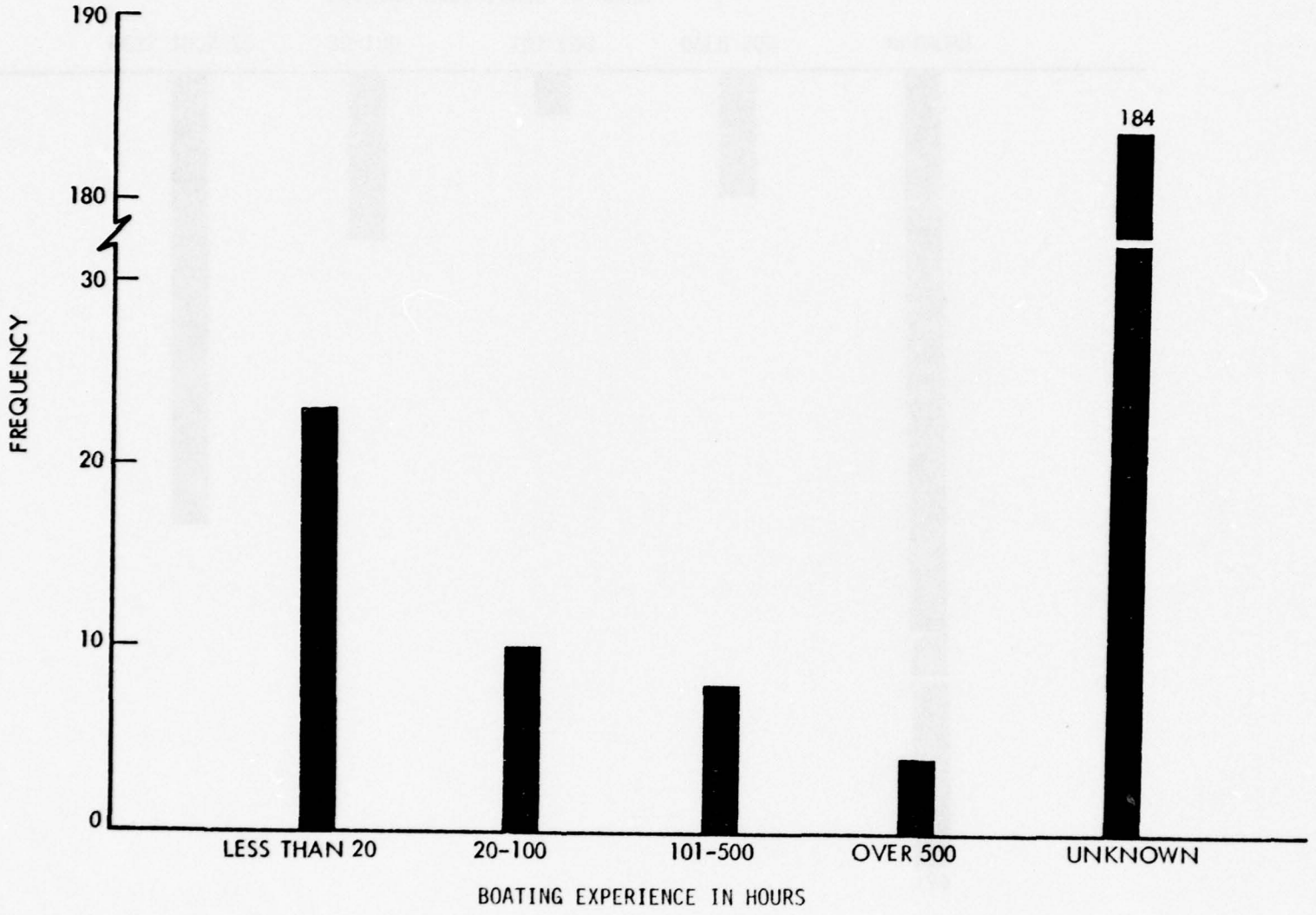


FIGURE 4. DISTRIBUTION OF NUMBER OF CANOE SURVIVORS BY CANOE BOATING EXPERIENCE

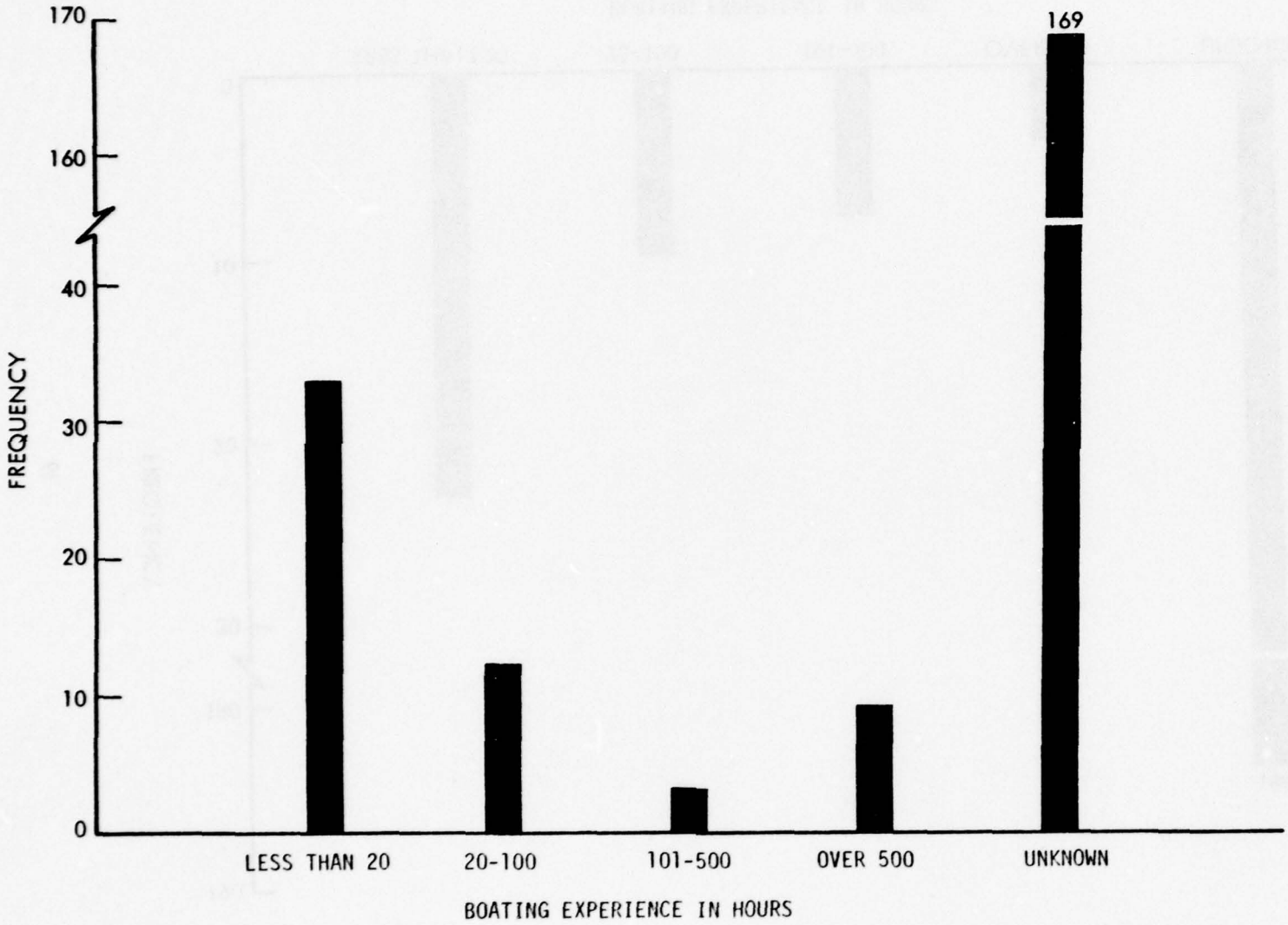


FIGURE 5. DISTRIBUTION OF NUMBER OF CANOE FATALITIES BY GENERAL BOATING EXPERIENCE

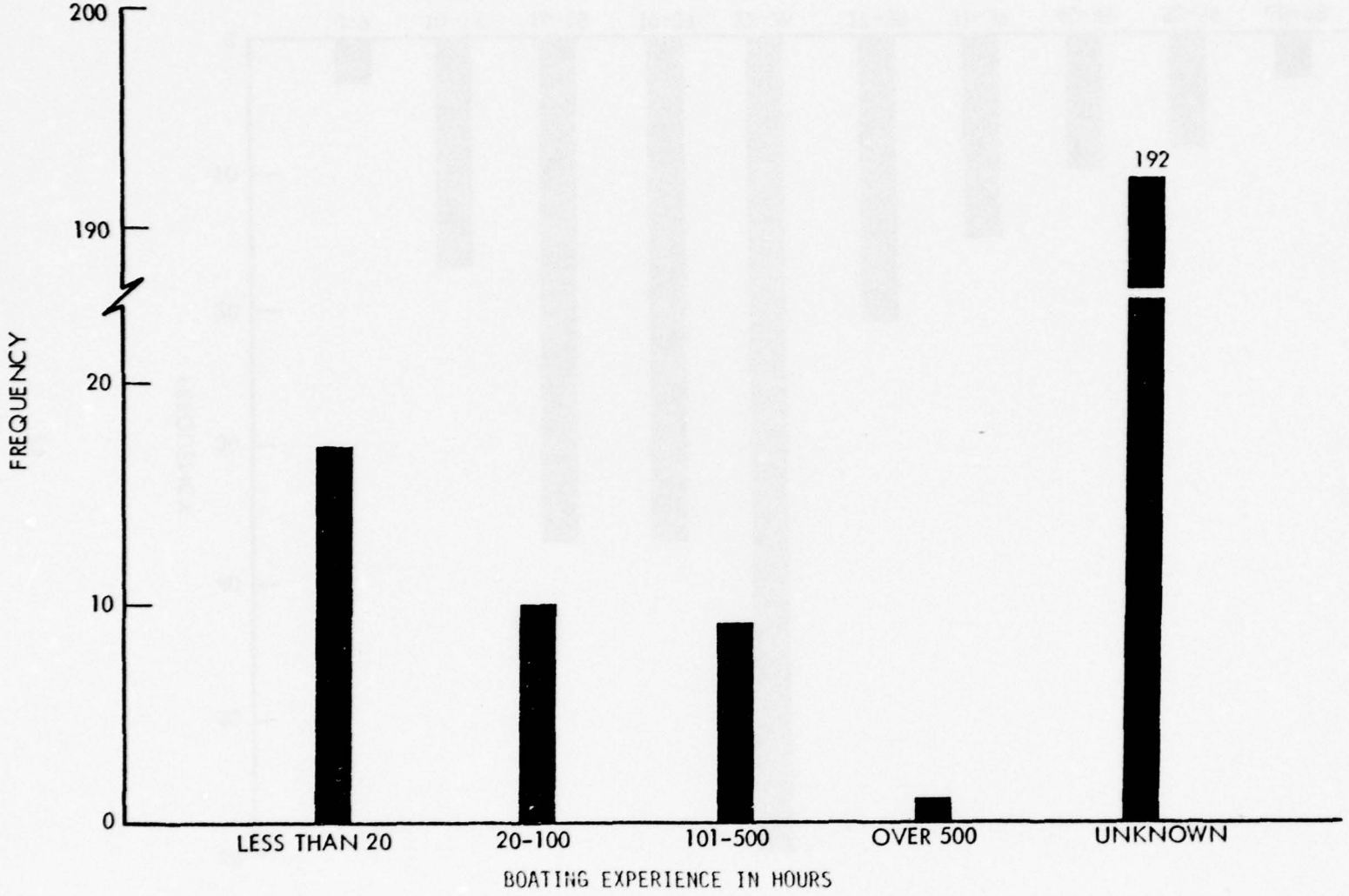


FIGURE 6. DISTRIBUTION OF NUMBER OF CANOE SURVIVORS BY GENERAL BOATING EXPERIENCE

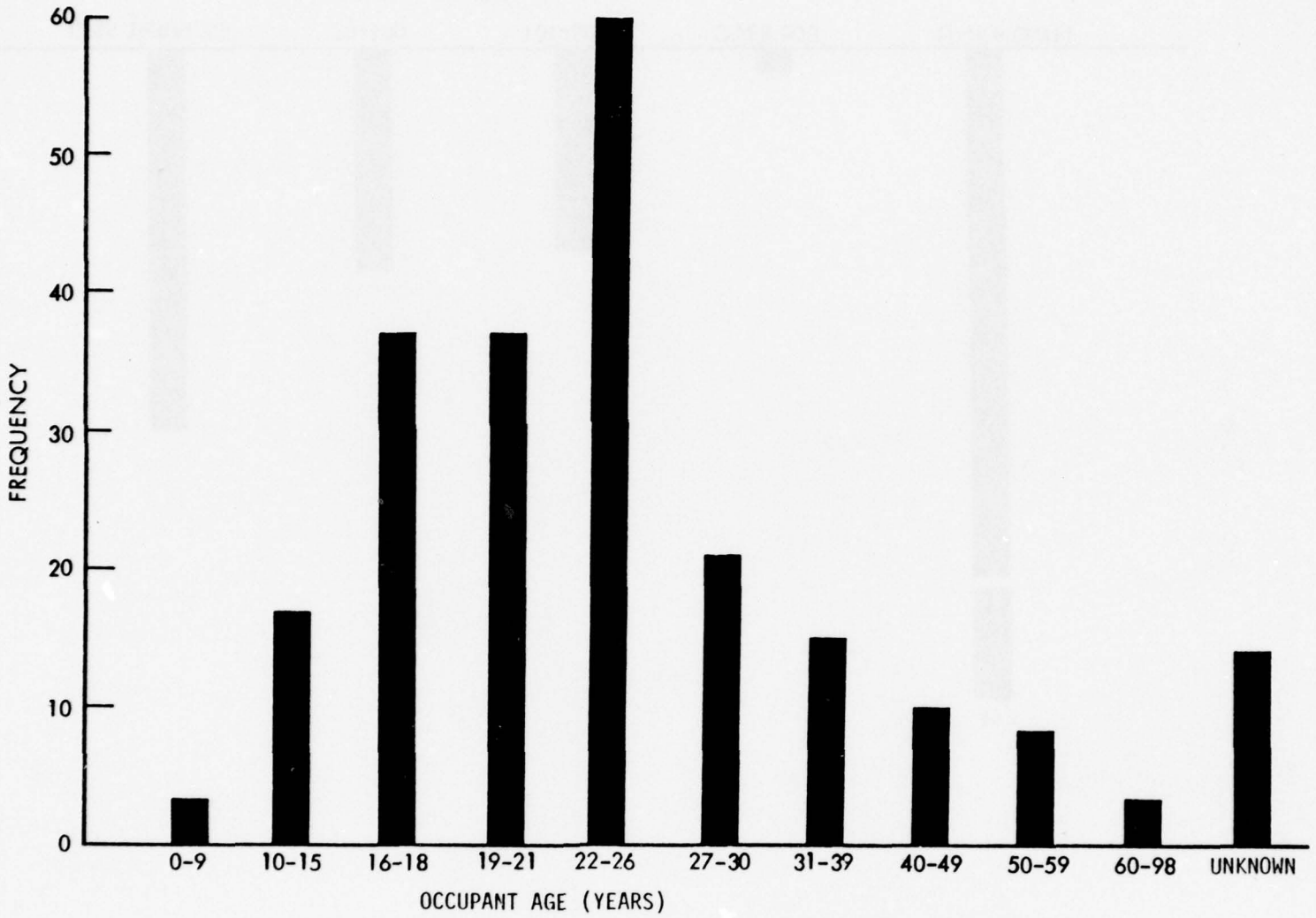


FIGURE 7. DISTRIBUTION OF NUMBER OF CANOE FATALITIES BY OCCUPANTS' AGE

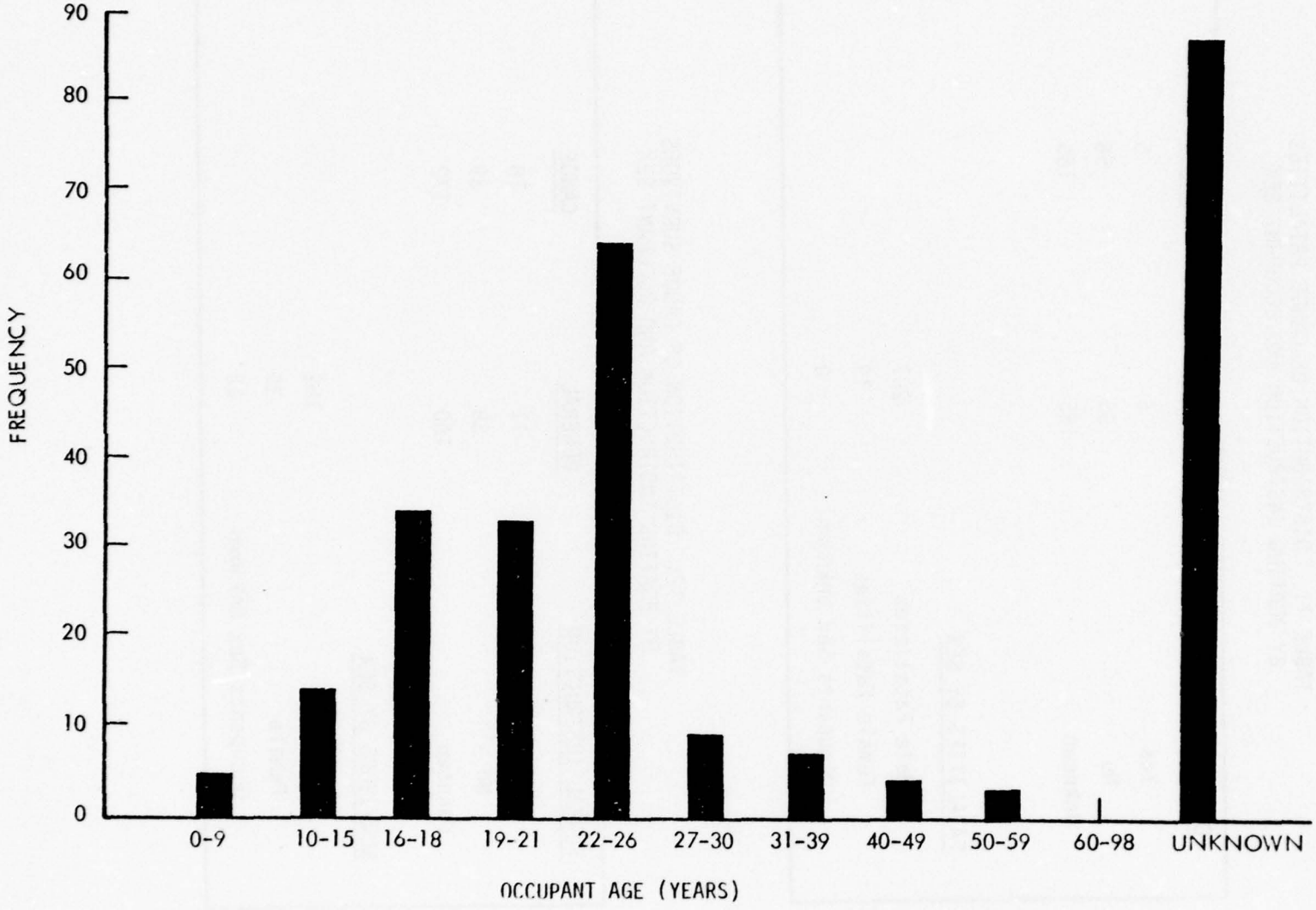


FIGURE 8. DISTRIBUTION OF NUMBER OF CANOE SURVIVORS BY OCCUPANT'S AGE

TABLE 11. DISTRIBUTION OF CANOE FATALITIES BY BOATING INSTRUCTION AND OCCUPANT SEX

FORMAL INSTRUCTION	GENERAL	CANOE
Yes	5	5
No	56	56
Unknown	165	165

FATALITIES BY SEX	
Male Fatalities	207
Female Fatalities	19
Occupants Sex Unknown	0

TABLE 12. DISTRIBUTION OF CANOE SURVIVORS BY BOATING INSTRUCTION AND OCCUPANT SEX

FORMAL INSTRUCTION	GENERAL	CANOE
Yes	11	18
No	38	39
Unknown	180	172

SURVIVORS BY SEX	
Male	182
Female	25
Occupants Sex Unknown	22

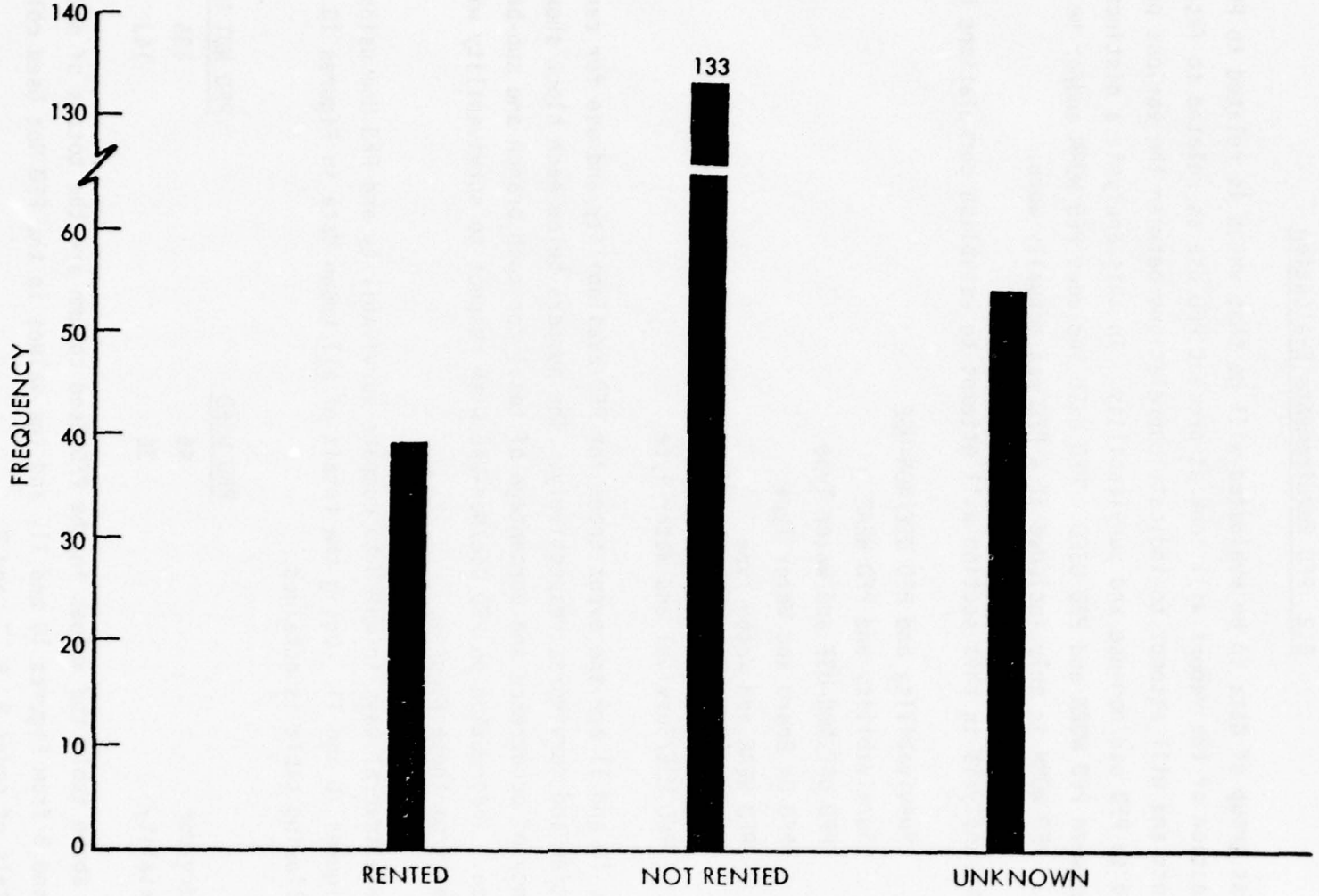


FIGURE 9. NUMBER OF CANOE FATALITIES FOR RENTED BOATS AND PRIVATELY OWNED BOATS

6.2 PFD Requirements Evaluation

The next group of data to be evaluated will be that which is related to PFD use. This section of the report will look at present PFD use as related to fatal canoe accidents and will attempt to indicate correlations between the various parameters related to PFD use/non-use and survivability. In this analysis a distinction is made between PFD WORN and PFD USED. PFD USED includes PFD WORN and/or held in any manner. PFD WORN is only included if a PFD was actually worn.

The data analysis in this section will attempt to establish correlations between:

- Survivability and PFD USE/NON-USE
- Survivability and PFD WEAR
- PFD USE/NON-USE and Water Type
- PFD On Board and Water Type
- PFD WEAR and Water Type
- Survivability and Water Type
- PFD USE/Survival and Water Type

Figures 10 and 11 are the event trees for PFD availability and use for canoe fatalities and survivors, respectively. The numbers below each block show the frequency of occurrence and percentage of total for each branch and sub-branch of the tree. Information on PFD Use/Non-Use with respect to survivability will be obtained from these figures.

There are several ways in which to compare survivability and PFD Use using the data from Figures 10 and 11. Using the totals of all known data in Figures 10 and 11, the following table is obtained.

	PFD USED	PFD NOT USED
Survivor	46	135
Fatality	36	143

In the above table the values in the PFD Used column are the totals of nodes 0, 1, 3, 4, and 5 from Figures 10 and 11, and the values in the PFD Not Used column are the totals of nodes 2, 6, 7, and 8.

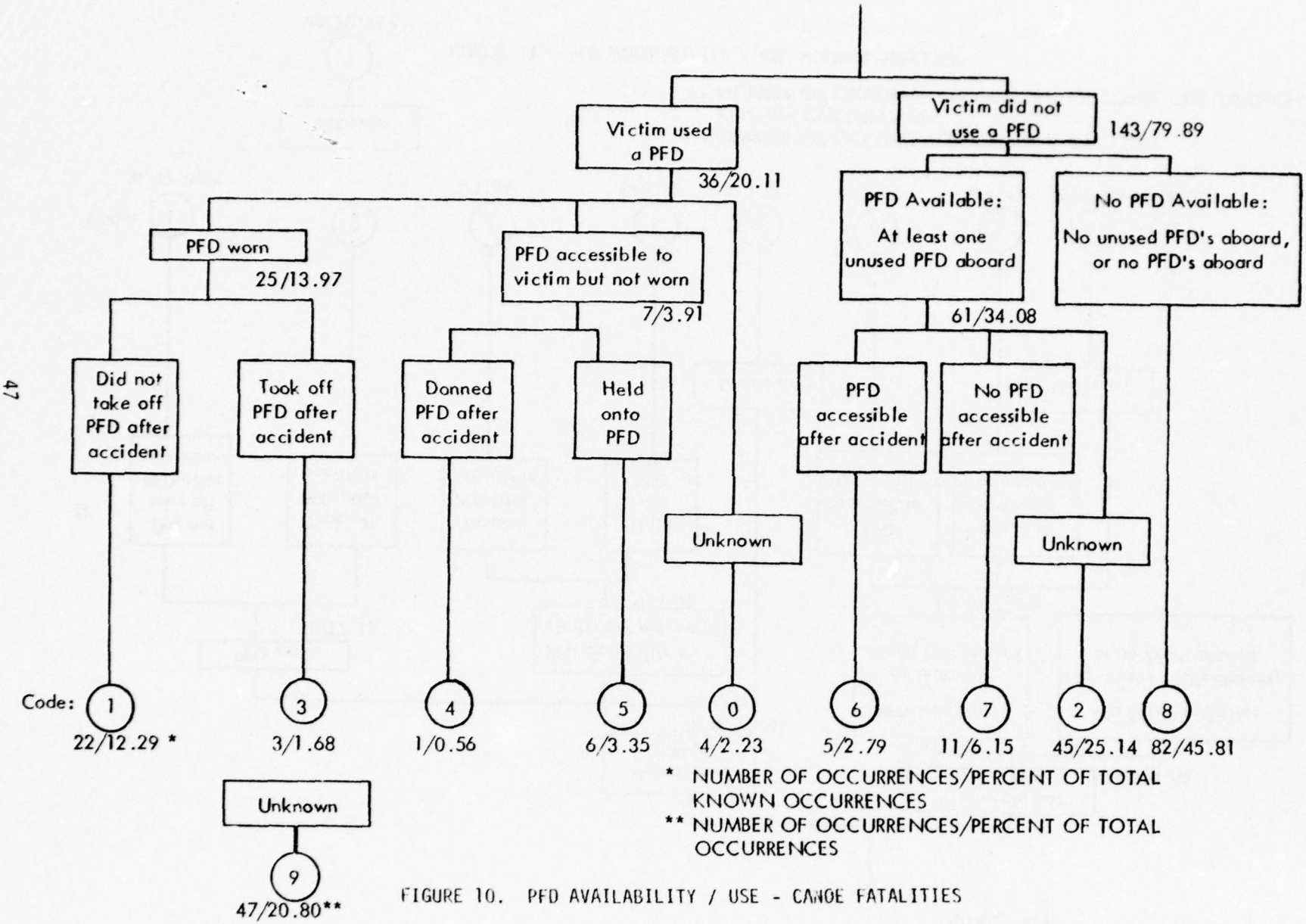
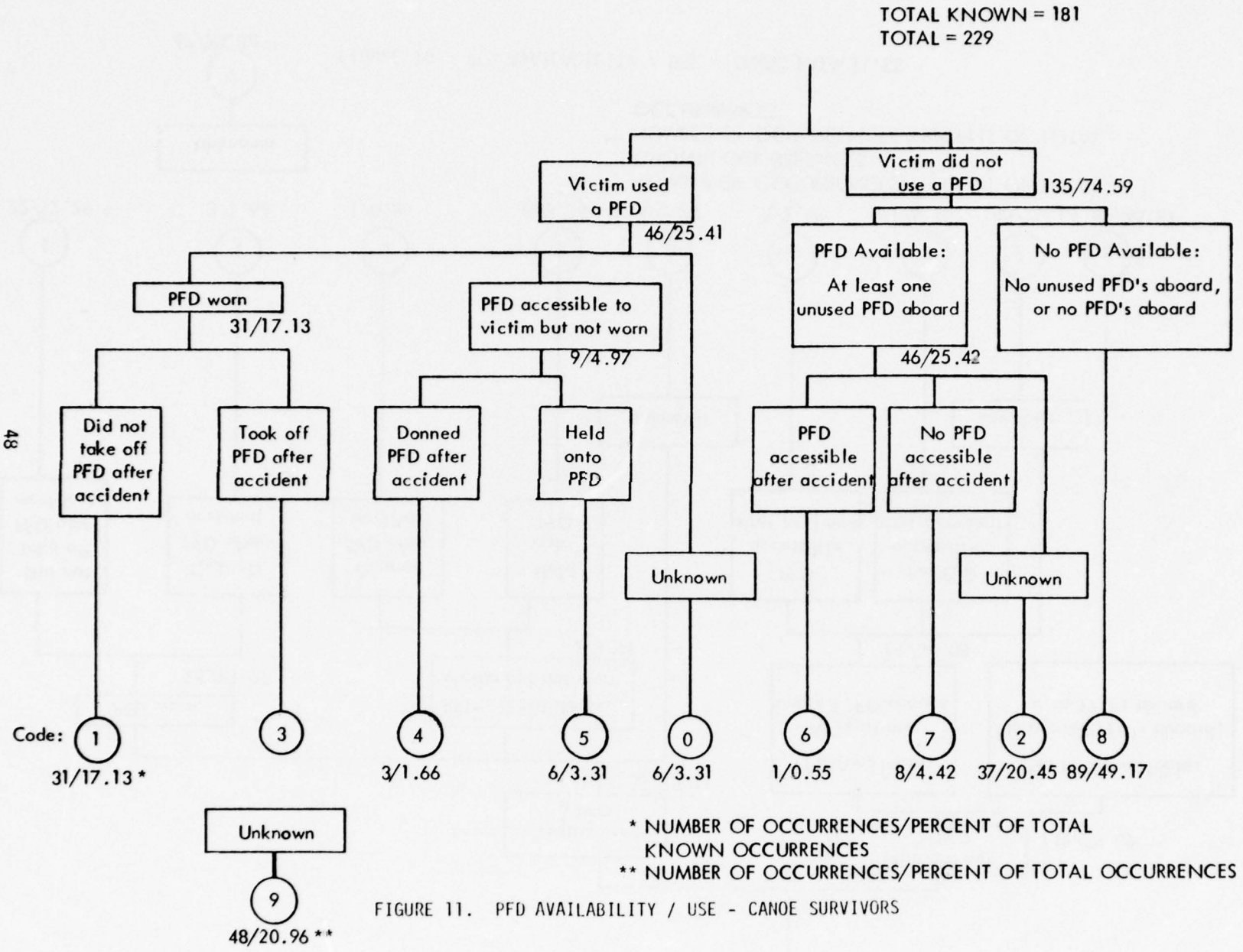


FIGURE 10. PFD AVAILABILITY / USE - CANOE FATALITIES



* NUMBER OF OCCURRENCES/PERCENT OF TOTAL KNOWN OCCURRENCES

** NUMBER OF OCCURRENCES/PERCENT OF TOTAL OCCURRENCES

FIGURE 11. PFD AVAILABILITY / USE - CANOE SURVIVORS

To determine if PFD use or non-use has a significant correlation with the outcome of an accident resulting in a fatality or a recovery, a Chi-square statistical significance test was performed on the data.

For this data $\chi^2 = 1.15$ which indicates that the correlation between PFD use and survivability is not statistically significant at confidence levels above 70%, which means that there is a 30% probability that the results are what they are by chance, and not due to a correlation between the variables examined.

Next, looking at PFD Worn and PFD Not Worn, where PFD Not Worn includes PFD not used and PFD used but not worn, the following table is constructed, again using the elements of Figures 10 and 11.

	PFD WORN	PFD NOT WORN
Survivors	34	141
Fatalities	23	152

For this table the values in the PFD Worn column are the totals of nodes 1 and 4 from Figures 10 and 11 and the values in the PFD Not Worn column are the totals of nodes 2, 3, 5, 6, 7, and 8 from Figures 10 and 11. For these values a χ^2 of 2.1 is obtained. This is statistically significant at a confidence level of 85%. The above analysis compares PFD Worn to PFD Not Worn for all occupants for which PFD use was known. This sample includes victims for which no PFD was available. If the cases for which no PFD was available are eliminated from the sample, the following table is obtained.

	PFD WORN	PFD NOT WORN
Survivors	34	52
Fatalities	23	70

χ^2 for these values is 3.86 which is significant at a confidence level of 95%. This shows, then, that given a fatal accident with a PFD available, chances of surviving when the PFD is worn are greater than when the PFD is not worn and not used.

Since survivability and PFD wear may be related to severity of conditions, these variables were also subjected to analysis.

Table 13 shows a comparison between PFD use/non-use and water type for <u>all</u> victims. A χ^2 of 6.39 was obtained for this data.

TABLE 13. PFD USE BY WATER TYPE

WATER TYPE	PFD USED	PFD NOT USED
Still, Slow	32	152
Fast Rapids, etc.	49	118

This is statistically significant at a confidence level of 98% and shows that water type is correlated to PFD use after accident initiation.

The next step then is to see if there is a correlation between PFD on board and Type of Water.

Table 14 shows the distribution of PFD on board by type of water for all victims involved in canoe accidents.

TABLE 14. DISTRIBUTION OF PFDS ON BOARD BY WATER TYPE

WATER TYPE	PFDS ON BOARD							
	0	1	2	3	4	5	6	UNK
Still	69	12	49	20	17	0	0	10
Slow	10	4	10	8	2	0	0	11
Fast	33	0	27	12	4	0	0	17
Rapids	20	0	31	7	0	2	3	6
Falls	2	0	4	2	0		0	0
Dams	5	0	24	3	0		0	13
Unknown	8	2	0	0	0		0	8

Summarizing this table by simplifying it into two types of water and a "Yes"/"No" category for any PFDs on Board, the following is obtained for the known data.

WATER TYPE	PFD ON BOARD	
	Yes	No
Still, Slow	122	79
Fast Rapids, etc.	119	60

Performing a χ^2 test on this data, a χ^2 of 1.13 is obtained. This is not significant and shows that there is no significant correlation between water type and the presence of a PFD on boats involved in fatal accidents.

To determine whether there is a relationship between PFD wear and water type, a χ^2 test can be performed for the following data (data is taken from the tables in Appendix C). (PFD Worn corresponds to nodes 1 and 4; PFD Not Worn corresponds to all other nodes in Figure 10.)

	PFD WORN	PFD NOT WORN OR USED
Still, Slow	24	160
Fast, Rapids, etc.	29	139

For this data, $\chi^2 = 0.91$, which is not significant. This shows that PFD wear is not related to type of water for the data base used.

A slightly different approach was then taken to analyze the above data.

Another statistical test which can be performed to determine the existence of a relationship between type of water and PFD use/non-use involves obtaining confidence intervals assuming a binominal distribution of the data and plotting the results for analysis.

Table 15 presents the data for PFD use as a function of type of water for fatalities and survivors.

TABLE 15. DISTRIBUTION OF PFD USE BY WATER TYPE

	FATALITIES		SURVIVORS	
WATER TYPE	PFD USED	PFD NOT USED	PFD USED	PFD NOT USED
Still/Slow	11	81	21	71
Fast Rapids Falls Dams	24	59	25	59

Using the values from Table 15, Table 16 can be constructed.

TABLE 16. SUMMARY OF PFD USE BY WATER TYPE

	PFD USED	PFD NOT USED
Still/Slow	P_1 = 11/32 = 0.344	P_2 = 81/152 = 0.533
Fast/ Rapids, etc.	P_3 = 24/49 = 0.490	P_4 = 59/118 = 0.50

Where $P_i = \frac{X_i}{N_i}$; X_i = the number of fatalities in i^{th} cell; N_i = total number of accident victims in i^{th} cell.

Calculating the standard deviation for each P_i using $sp_i = \sqrt{P_i Q_{i/N_i}}$

where $Q_i = 1 - P_i$; N_i is defined as above, the following values are obtained:

$sp_1 = 0.084$ $\quad$ $sp_3 = 0.071$

$sp_2 = 0.040$ $\quad$ $sp_4 = 0.046$

Plotting the values obtained as $P_i \pm sp_i$, the graph as shown in Figure 12 is obtained. For this type of graph, conditions with non-overlapping intervals are significantly different.

As can be seen from Figure 12, the percent of fatalities in PFD USED, STILL, SLOW, cell is significantly lower than the percent of fatalities in the PFD NOT USED, STILL, SLOW cell. There is no significant difference between PFD NOT USED, STILL, SLOW: PFD USED, FAST, RAPIDS, ETC. AND PFD NOT USED, FAST, RAPIDS, ETC. This data shows that for the data base used, the chances of survival are better when a PFD is used in still or slow water than if not used; but in fast water, rapids, falls, and dams, just using a PFD does not alter ones chances of survival.

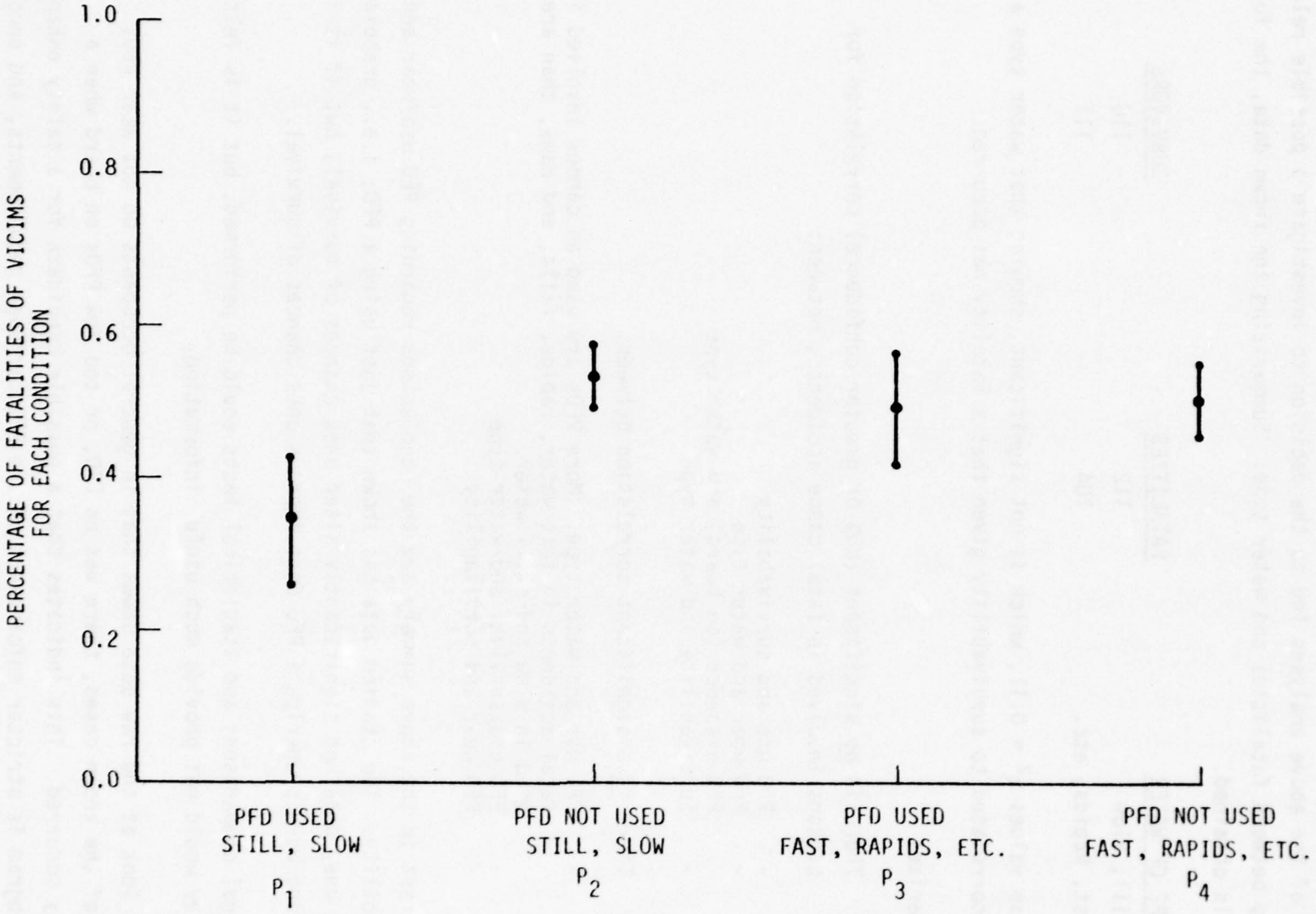


FIGURE 12. CORRELATION OF PFD USE WITH WATER TYPE

Results of the above analyses led to the decision to investigate a possible relationship between fatalities and water type. Summarizing the known data, the following is obtained.

TYPE OF WATER	FATALITIES	SURVIVORS
Still, Slow	112	110
Fast, Rapids, etc.	104	111

For these values $\chi^2 = 0.11$, which is not significant, showing that water type alone is not correlated to survivability given that a fatality has occurred.

To summarize:

- There is no significant (80% or greater confidence) correlation for persons involved in fatal canoe accidents, between:
  - PFD use and survivability
  - PFD wear and water type
  - PFD presence (on board) and water type
  - Survivability and water type
- There is a significant correlation between:
  - PFD use and water type. More PFDs are used on canoes involved in fatal accidents in fast water, rapids, falls, and dams, than are used in slow and still water.
  - PFD use/survival and water type
  - PFD wear and survivability

Of interest in the above summary are the conclusions regarding PFD use/wear and survivability. The studied data has shown that just using a PFD; i.e., grabbing hold of one, does not significantly alter ones chances of survival; but if it is donned and worn properly, a PFD does improve ones chances of survival.

Additional comparisons and statistical tests could be performed, but it is felt that they would not provide much useful information.

A basic look at the raw data shows that in general occupants do not wear PFDs. For 86 of the known cases, there was no PFD, or too few PFDs on board when a fatality occurred. This indicates that a possible candidate for a safety enhancement program is stricter enforcement of the PFD carriage requirements, and encouragement/education to induce the occupants to wear a PFD. In the cases where a PFD was used and the victim still died, 32 out of 36 times it was death by drowning.

Three cases appeared to be death due to hypothermia, and in one case fatal injuries were the cause of death. In 18 of 32 cases, when the PFD was worn, death was due to drowning. It is not known if the PFDs were donned and adjusted properly. In any case the number of deaths by drowning when the victim apparently used a PFD indicates a need to determine the precise cause of apparent PFD failure, and evaluation of a possible increase in effectiveness of present PFDs.

6.3 Vessel Flotation Considerations

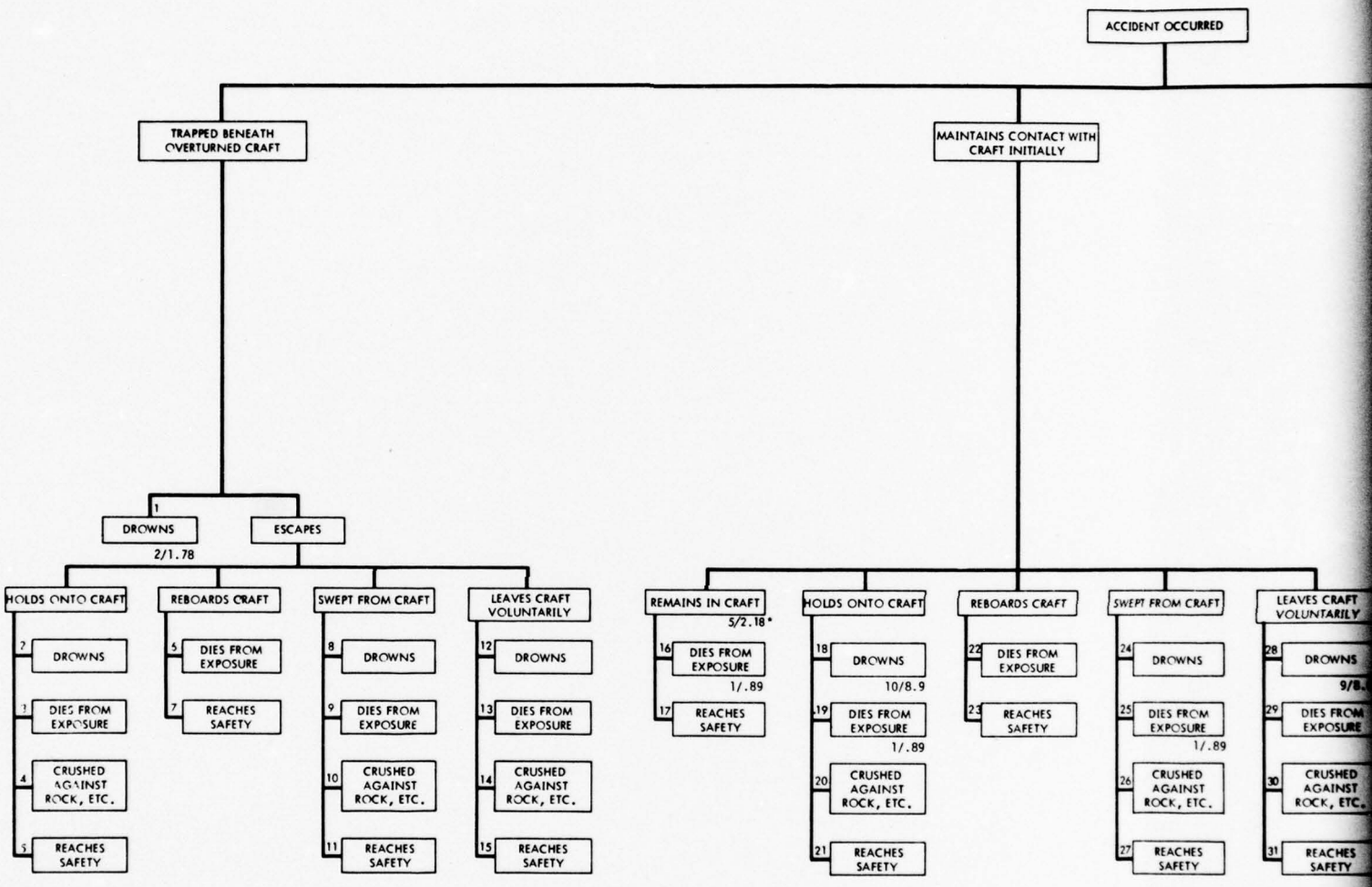
The third area that will be evaluated as a potential area for a safety enhancement program is vessel flotation. To initiate this analysis, the assumption must be made that vessel flotation could be altered to make a canoe a safer, more stable and effective recovery platform. Earlier work has shown that canoe flotation can be adjusted to provide a more stable recovery platform (Reference 4). This will be further discussed later in this report.

The population which may benefit from vessel flotation should be identified at this time. It appears that the victims most likely to benefit from vessel flotation are those who have accidents in slow and still water. In fast water and rapids it is common practice to get upstream and away from the canoe to prevent being pinned between the canoe and a hard place (rock, tree, piling, etc.). For this reason, analysis of potential benefits of vessel flotation will primarily be done for victims of accidents occurring in still and slow water.

Of the accidents evaluated, 112 out of 226, or 49%, of the total of accident fatalities were known to have occurred in still and slow water (this is 52% of fatalities with known water conditions). Figure 13 should be examined at this time to determine how many of these 112 people could have benefitted from increased vessel flotation. Figure 13 shows occupants post-accident behavior for accidents occurring in still and slow water. Block 1 of Figure 13 indicates that two people were trapped beneath an overturned craft and drowned. It will be assumed that vessel flotation would not have prevented these fatalities. The next major category "Maintains Contact with Craft Initially" contains 22 fatalities. If it is assumed that increased

---

[4] Sautkulis, C. and Bowman, J., Preliminary Evaluation of The Loading, Powering and Flotation of a Sample of Canoes, Technical Brief 74-11 to USCG. Contract No. DOT-CG-40672-A. December 1974.


ACCIDENT OCCURRED
TRAPPED BENEATH OVERTURNED CRAFT
MAINTAINS CONTACT WITH CRAFT INITIALLY
1
DROWNS
2/1.78
ESCAPES
HOLDS ONTO CRAFT
REBOARDS CRAFT
SWEPT FROM CRAFT
LEAVES CRAFT VOLUNTARILY
2 DROWNS
3 DIES FROM EXPOSURE
4 CRUSHED AGAINST ROCK, ETC.
5 REACHES SAFETY
6 DIES FROM EXPOSURE
7 REACHES SAFETY
8 DROWNS
9 DIES FROM EXPOSURE
10 CRUSHED AGAINST ROCK, ETC.
11 REACHES SAFETY
12 DROWNS
13 DIES FROM EXPOSURE
14 CRUSHED AGAINST ROCK, ETC.
15 REACHES SAFETY
REMAINS IN CRAFT
5/2.18*
HOLDS ONTO CRAFT
REBOARDS CRAFT
SWEPT FROM CRAFT
LEAVES CRAFT VOLUNTARILY
16 DIES FROM EXPOSURE
1/.89
17 REACHES SAFETY
18 DROWNS
10/8.9
19 DIES FROM EXPOSURE
1/.89
20 CRUSHED AGAINST ROCK, ETC.
21 REACHES SAFETY
22 DIES FROM EXPOSURE
23 REACHES SAFETY
24 DROWNS
25 DIES FROM EXPOSURE
1/.89
26 CRUSHED AGAINST ROCK, ETC.
27 REACHES SAFETY
28 DROWNS
9/8.
29 DIES FROM EXPOSURE
30 CRUSHED AGAINST ROCK, ETC.
31 REACHES SAFETY

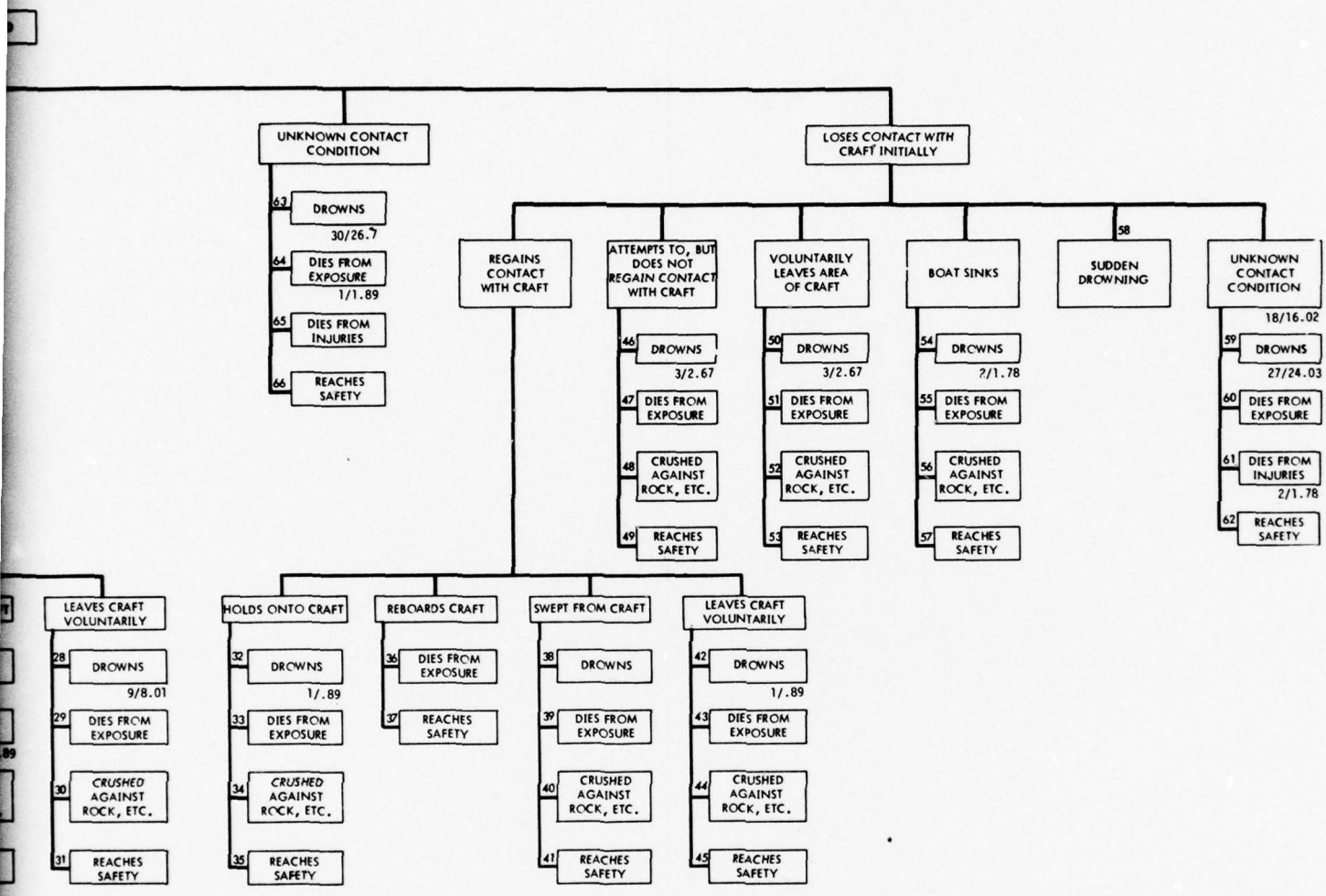


FIGURE 13. OCCUPANTS' POST-ACCIDENT SITUATION - CANOE FATALITIES STILL AND SLOW WATER

vessel flotation would have prevented the 9 victims from leaving the craft voluntarily, then these 22 fatalities may have been prevented through vessel flotation. The victims placed in the category "Loses Contact with Craft Initially" are evaluated next. It is assumed that the 18 victims in block 58, "Sudden Drowning," would not have benefitted from vessel flotation. They drowned so suddenly that they would probably not have been able to gain contact with the craft and make use of any flotation benefits. With regard to loss of contact with the craft, the following eventualities are possible if sufficient vessel flotation were present (given slow or no current):

- The victim drowns prior to regaining contact with the craft.
  - He drowns suddenly
  - He chooses not to return to the craft
  - The craft is blown away from him by the wind.
- The victim is able to return to the craft and survives.

Looking at the victims in the other categories under the major category, "Loses Contact with Craft Initially," and cross sorting by wind condition, Table 17 is obtained.

TABLE 17. OCCUPANTS BEHAVIOR BY WIND CONDITION

WIND CONDITION	NODE NUMBER IN POST-ACCIDENT EVENT TREE (FIGURE 13)							
	32	42	46	50	54	59	61	TOTALS
None	0	1	0	0	0	11	0	12
Light	1	0	0	2	0	6	1	10
Moderate	0	0	2	0	0	2	0	4
Strong	0	0	1	1	1	3	0	6
Storm	0	0	0	0	0	0	0	0
Unknown	0	0	0	0	1	5	1	7

This table shows that of the 39 victims (other than sudden drowning), 10 were involved in accidents when the wind was Moderate to Storm Conditions, leaving 22 occurring in None to Light Winds and allowing these victims to potentially benefit from vessel flotation. Thus far the total that may have been helped through vessel flotation is 22 that did not lose contact with the craft initially, plus 22 that lost contact initially but were in No Wind to Light Wind. There is one additional group that is shown in Figure 13; these are the victims for which it was not known if they lost contact or maintained initial contact with the craft. Table 18 shows the distribution by wind conditions for these victims.

TABLE 18. OCCUPANTS BEHAVIOR BY WIND CONDITION

WIND CONDITION	NODE NUMBER IN POST-ACCIDENT EVENT TREE (FIGURE 13)	
	63	64
None	3	0
Light	13	0
Moderate	0	0
Strong	7	1
Storm	3	0
Unknown	4	0

Assuming that those that occurred in Moderate to Storm Conditions were distributed in the same ratio as the known data, then those that could benefit from vessel flotation from this group would be 16 from No and Light Wind Conditions, plus $\left(\frac{22}{61}\right)$ (11) = 3.97 ~ 4, where $\frac{22}{61}$ is the ratio of "maintains contact" fatality to "maintains contact" fatalities <u>plus</u> "loses contact" fatalities (excluding Sudden Drownings).

This brings the total number of fatalities that might have benefited from vessel flotation to:

22 Did not lose contact initially (Nodes 16, 18, 19, 25, 28 of Figure 13)

22 Lost contact in None to Light Wind (Percentage of Nodes 32, 42, 46, 50, 54, 57, 61 of Figure 13)

16 Unknown contact in None to Light Wind (Percentage of Nodes 63, 64 of Figure 13)

<u>4</u> Unknown contact - assumed maintained contact (Percentage of Nodes 63, 64 of Figure 13)

64

The nodes used in Tables 17 and 18 are not all of the nodes that need to be included in a benefit estimate. They were the only ones included in this estimate since, as can be seen from Figure 13, they were the only nodes that identified fatalities in the data base used. The following table lists all of the nodes with their corresponding probability of being included in a benefit estimate.

PROBABILITY OF BENFITING FROM FLOTATION	NODE NUMBER IN FIGURE 13
HIGH PROBABILITY	2, 3, 8, 9, 12, 13, 16, 18, 19, 22, 24, 25, 28, 29, 32, 33, 36, 38, 39, 42, 43
MODERATE PROBABILITY	46, 47, 50, 51, 54, 55, 59, 60, 63, 64, 65
LOW PROBABILITY	1, 4, 10, 14, 20, 26, 30, 34, 40, 44, 48, 52, 56, 58, 61, 65

Caution must be used when applying this table to a benefit estimate. The assignment of nodes to probability utilizes several assumptions. The assumption was made that canoe flooded performance could be such that it reduced the submergence of a person in water, thus decreasing his chances of dying from hypothermia. It was also assumed that the canoe could be made easier to maintain contact with in a flooded condition. It is realized that in an evaluation of benefits for still and slow water, some of the nodes will likely never contain an occupant count in that the tree was developed for use with all types of water; however, all possible nodes were included in the previous table.

One other important assumption was made on assigning nodes to probabilities, that is the occupants behavior can be modified such that they will make use of the available floating platform provided by the flotation in the canoe.

Since this was a first estimate of potential benefit through the use of vessel flotation for canoes and since details of accident events downstream of the accident area could not be analyzed for a more precise estimate, all nodes with occupant counts in them were considered in the data base for the previous estimate. This includes the two occupants in node 61 which was assigned a low probability. At this stage of the research, it is a matter of opinion as to whether or not it should have been included. It is felt that the low count in the node combined with the uncertainty of attainable performance criteria allowed this node to be included without adversely affecting the results.

It is realized that not 100% of these fatalities would have been prevented. It is also quite possible that some fatalities in the categories that were eliminated from the previous analysis would be prevented by increased flotation. As an example, it is not known how many victims in fast water, rapids, etc., would have been reunited with their craft downstream and would have been able to take advantage of vessel flotation.

For lack of better data, it can be assumed that the number of fatalities that were classified as "possibly preventable" that would actually not be prevented is roughly balanced by the number of eliminated fatalities that would be prevented. (Until a specific canoe flotation performance criteria is developed, the estimate can not be further refined.) Based on the latter assumption, an estimated maximum of 64 fatalities prevented over the two year period is realized, or 32 lives saved per year. As there were 226 fatalities in canoes over that same two year period in the data base, this prediction amounts to a maximum of a 28.3% fatality reduction.

The percent reduction that was estimated for outboard boats (Reference 5) was 20% of the total number of fatalities that occurred in boats that would be affected by the level flotation standard. This initial benefit estimate shows that the potential benefit that could be realized for canoes is on a par with that for "level flotation affected boats."

Reference 4 has shown that canoe flotation could be altered to make the vessel more stable and more easily boarded in Still and Calm Water. Looking at Figure 14, the final condition of the craft can be seen. Looking at the known data, in 78 out of 103 cases or 76% of the time the craft remained accessible. Since the flotation condition of the involved vessels could not be accurately determined, it is not known just how much vessel flotation needs to be improved. It appears that in-depth investigations of canoe accidents would be the most reliable method of determining what would be sufficient for flotation requirements as well as PFD use and educational alternatives. A rough estimate of the possible cost effectiveness of increased flotation for canoes can be deduced from the following information:

- The percentage of the total canoe fatalities which could be prevented by increased flotation appears to be roughly equivalent to that for outboards (28.3% for canoes vs. 20% for outboards).

[5] Kissinger, J. R., An Analysis of 1974 Fatal Boating Accidents - Predicting the Effectiveness of a Level Flotation Standard, USCG Final Report, April 1976.

- The fatalities per vessel for canoes is roughly twice that for outboards (Section 3).
- The cost of increased flotation for canoes, on a per boat basis (assuming uncovered polyethelene foam is allowed), should not exceed that for the average outboard.

Therefore, the benefit per vessel for canoes will be approximately twice that for outboards, based on the above statements. If the cost per boat is less than or equal to that of outboards, then the benefit to cost ratio for canoes may well be twice as high as outboards. Only further testing and analysis can establish accurate cost/benefit predictions. The above serves to establish that the cost/benefit potential for canoes exceeds that which appeared for outboards at the same stage of the outboard level flotation research effort.

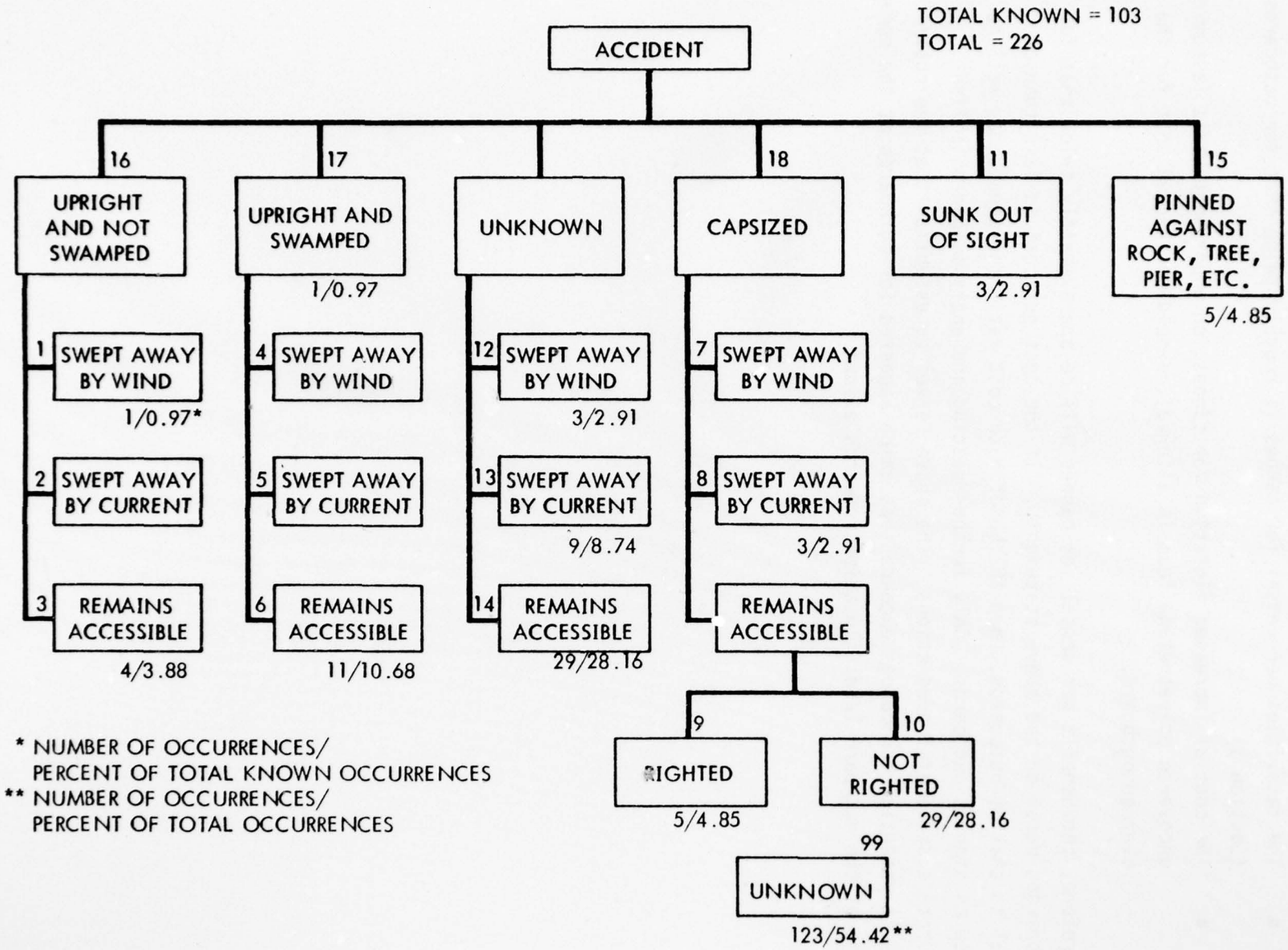


FIGURE 14. FINAL CONDITION OF CRAFT - CANOE FATALITIES

7.0 DATA ANALYSIS - INFLATABLES

Since the sample size is even smaller for inflatables than it is for canoes, the previously mentioned limitations placed on statistical evaluation of the data are compounded. Therefore, this section will be limited to discussions of several of the more significant variables in light of the way they may affect education, PFD and flotation safety enhancement requirements.

Table 19 shows that one state, California, accounts for 28% of all the fatalities involving inflatable craft. Information was not available to determine if this is simply due to more exposure (i.e., higher use rate), or whether some factor is responsible for a high death rate.

Table 20 shows that 79% of the fatalities reviewed involved either the capsizing of the craft or a person(s) falling overboard.

Table 21 shows that 83% of the fatalities occurred with craft containing 1 to 3 persons. This indicates that passenger overloading is probably not a principle cause for fatal accidents in inflatables.

Table 22 shows that only one person out of 86 fatalities in the data base used was known to have had any formal instruction in general boating or in inflatable craft boating. However, it is significant to note that the instruction status of 73% of the fatalities is unknown. If the percentage of instructed to non-instructed for the unknown group is the same ratio as that for the known, it would mean that only 3 of 86 or 3.4% of the fatalities had any formal instruction.

Table 23 shows comparable results for boating experience. While 85% of the fatalities have unknown experience levels, of those whose experience is known, 10 (77%) had less than 100 hours of boating experience and only 3 (23%) had more than 100 hours experience.

Of the cases studied, only one fatality was recorded as being associated with a rental boat. This indicates that efforts aimed specifically at renters would reap narrow benefits.

TABLE 19. INFLATABLE FATALITIES BY STATE

STATE	# FATALITIES	N = 86 % TOTAL	N = 86 % KNOWN
California	24	27.91	27.91
Ohio	6	6.98	6.98
Pennsylvania	6	6.98	6.98
Oregon	5	5.81	5.81
Michigan	4	4.65	4.65
Montana	4	4.65	4.65
Wisconsin	4	4.65	4.65
Connecticut	3	3.49	3.49
Massachusetts	3	3.49	3.49
Alaska	2	2.33	2.33
Colorado	2	2.33	2.33
Florida	2	2.33	2.33
Iowa	2	2.33	2.33
New York	2	2.33	2.33
North Carolina	2	2.33	2.33
South Carolina	2	2.33	2.33
Tennessee	2	2.33	2.33
Utah	2	2.33	2.33
Alabama	1	1.16	1.16
Arizona	1	1.16	1.16
Kansas	1	1.16	1.16
Kentucky	1	1.16	1.16
Maryland	1	1.16	1.16
Minnesota	1	1.16	1.16
Washington	1	1.16	1.16
West Virginia	1	1.16	1.16
Wyoming	1	1.16	1.16

TABLE 20. INFLATABLE FATALITIES BY ACCIDENT TYPE

ACCIDENT TYPE	# INFLATABLE FATALITIES	N = 86 % TOTAL	N = 80 %KNOWN
Capsizing	55	63.95	68.75
Swamping	7	8.14	8.75
Falls Overboard	13	15.12	16.25
Collision	1	1.16	1.25
Jump Overboard	4	4.65	5.00
Unknown	6	6.98	-----

TABLE 21. INFLATABLE FATALITIES BY PEOPLE ON BOARD

PERSONS ON BOARD	# FATALITIES	N = 86 % TOTAL
1	13	15.12
2	46	53.49
3	13	15.12
4	4	4.65
5	4	4.65
6	6	6.98
7	0	-----
8	0	-----
9	0	-----
Unknown	0	-----

TABLE 22. INFLATABLE FATALITIES BY BOATING INSTRUCTION

FORMAL BOATING INSTRUCTION - GENERAL	# INFLATABLE FATALITIES	N = 86 % TOTAL	N = 23 % KNOWN
Yes	1	1.16	4.35
No	22	25.58	95.65
Unknown	63	73.26	-----
FORMAL BOATING INSTRUCTION - INFLATABLE	**# INFLATABLE FATALITIES**	**N = 86 % TOTAL**	**N = 23 % KNOWN**
Yes	1	1.16	4.35
No	22	25.58	95.65
Unknown	63	73.26	-----

TABLE 23. INFLATABLE FATALITIES BY BOATING EXPERIENCE

OCCUPANT'S BOATING EXPERIENCE - INFLATABLE	# INFLATABLE FATALITIES	N = 86 % TOTAL	N = 13 % KNOWN
Less than 20 hrs	7	8.14	53.85
20 to 100 hrs	3	3.49	23.08
100 to 500 hrs	1	1.16	7.69
Greater than 500 hrs	2	2.33	15.38
Unknown	73	84.88	-----
OCCUPANT'S BOATING EXPERIENCE - TOTAL	**# INFLATABLE FATALITIES**	**N = 86 % TOTAL**	**N = 13 % KNOWN**
Less than 20 hrs	7	8.14	53.85
20 to 100 hrs	3	3.49	23.08
100 to 500 hrs	1	1.16	7.69
Greater than 500 hrs	2	2.33	15.38
Unknown	73	84.88	-----

Table 24 indicates that most of the inflatable-associated fatalities occurred in whitewater conditions with 81% in the data base being recorded in rivers or creeks with fast water, rapids, or around dams.

Table 25 shows that of the 49 boats in the data base whose final condition is known 24 were inaccessible to passengers due to being swept away by fast current or wind.

Inflatable data also shows that there were no or insufficient PFDs on board in 75% of the known cases (Appendix C).

7.1 Education Alternatives

From the limited number of cases for which boating experience was known, it can be seen that, as general boating experience and inflatable boating experience increase, the number of fatalities decreases. The present data also shows that a great majority of the fatalities occurred in rapids. It appears that experience and education are important to boater safety, as a special expertise is required to cope with such an unfamiliar and challenging environment. Instruction should be aimed at the beginner, perhaps at the time that he is buying his craft.

7.2 PFD Requirements Evaluation

The data base utilized indicates that of the accidents involving fatalities, there was insufficient use of PFDs. Either there were no PFDs available to the victims or they failed to wear them. This is an important factor to survivability from accidents involving inflatables, since the data shows that in many cases the inflatable boat is swept away and is thus inaccessible to the victims. If a user clearly understands that there is a high probability that he will not have access to his vessel in case of an accident, he will likely depend on a PFD more readily. Therefore, enforcement of PFD carriage requirements should be accompanied by education of the boaters.

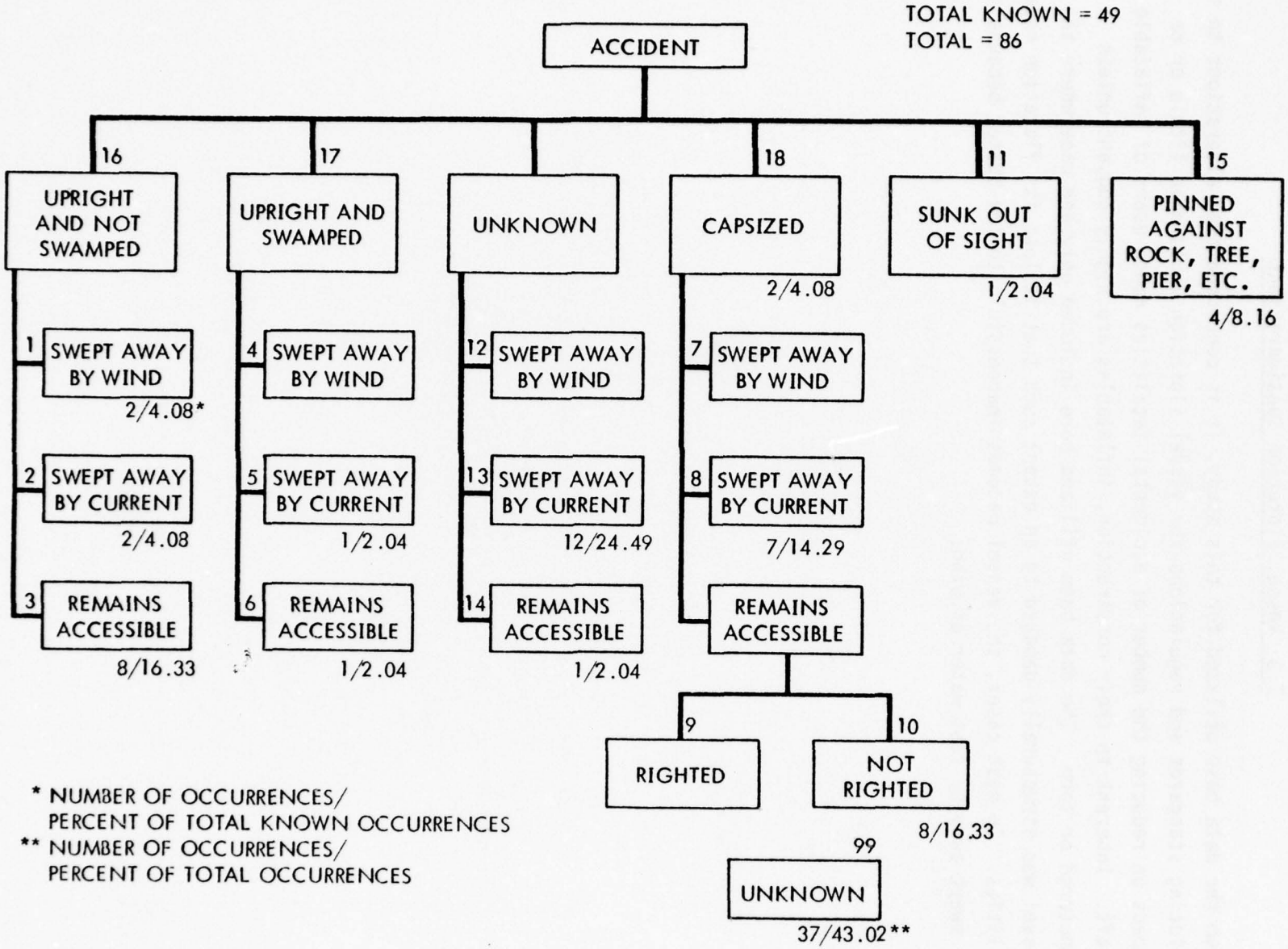
TABLE 24. INFLATABLE FATALITIES BY WATER ENVIRONMENT

BODY OF WATER	# INFLATABLE FATALITIES	N = 86 % TOTAL	N = 86 % KNOWN
River, Creek	70	81.40	81.40
Lake, Pond	8	9.30	9.30
Great Lakes	0	-----	-----
Coastal Waters	6	6.98	6.98
Ocean	2	2.33	2.33

TYPE OF WATER	# INFLATABLE FATALITIES	N = 86 % TOTAL	N = 86 % KNOWN
Still	9	10.47	10.47
Slow	4	4.65	4.65
Fast	34	39.53	39.53
Rapids	20	23.26	23.26
Falls	3	3.49	3.49
Dam	16	18.60	18.60

WATER CONDITIONS	# INFLATABLE FATALITIES	N = 86 % TOTAL	N = 72 % KNOWN
Calm	8	9.30	11.11
Choppy	6	6.98	8.33
Rough	15	17.44	20.83
Rapids, Falls, Dam	43	50.00	59.72
Unknown	14	16.28	-----

TABLE 25. FINAL CONDITION OF CRAFT - INFLATABLE FATALITIES



* NUMBER OF OCCURRENCES/
PERCENT OF TOTAL KNOWN OCCURRENCES

** NUMBER OF OCCURRENCES/
PERCENT OF TOTAL OCCURRENCES

7.3 Vessel Flotation Considerations

From the data base utilized for this study, it is concluded that alterations to the existing standards and regulations for vessel flotation would have little or no impact on reducing the number of accidental fatalities among users of inflatable craft. Inherent to their construction, inflatables are highly buoyant unless punctured or torn. The data base utilized here included only one case where the vessel was structurally damaged to an extent such that it lost its flotation capabilities. In most cases, the vessel becomes inaccessible to the boater because it is swept away by fast water or wind.

8.0 DATA ANALYSIS - KAYAKS

The kayak data that is available for analysis is very limited due to the small number of kayak-related fatalities as seen in Table 26. Due to this small sample, no statistical evaluations are presented.

TABLE 26. KAYAK ACCIDENTS REVIEWED

1973		1975	
No. Accidents	6	No. Accidents	11
No. Occupants	11	No. Occupants	15
No. Fatalities	6	No. Fatalities	12

Table 9 in Section 4.0 showed the percentages of the data that were unknown. With the small number of fatalities and the large number of unknowns, it would be almost meaningless to perform statistical evaluations. Table 26, however, shows that there are almost twice as many accidents (1.83 times) in 1975 as in 1973. These accidents involved 1.36 times as many people and resulted in twice as many fatalities. The average number of occupants per accident was 1.83 in 1973 and 1.36 in 1975. Fatalities per accident were 1.0 in 1973 and 1.09 in 1975. We do not know the exposure rate for kayaks, so we cannot determine if the accident rate for kayaks has increased between 1973 and 1975. It is difficult to determine trends in accidents from only two years of data with so few data points per year. The difference between these two years may be accounted for by normal fluctuations in accidents each year, or they may indicate a potential problem developing with kayaks. The accident rate for kayaks should be watched closely during the upcoming years to determine whether a problem is developing. Preventative action should then be implemented at the earliest possible time.

There was not enough data to perform analyses of PFD, flotation, and education alternatives.

9.0 RESULTS AND CONCLUSIONS

The Tables 27 through 33 summarize the findings of this project. Additional discussion of the major findings follows:

- Relative to flotation: Increased flotation for canoes appears to have a fatality reduction potential roughly on par to level flotation for outboards. However, due to the apparently higher fatality rate for canoes, the benefit to cost ratio for canoes should be near twice that for outboards. The fatality reduction potential due to increased flotation in inflatables appears nonexistent; whereas, in kayaks, the reduction potential could not be assessed due to the low number of kayak fatalities using the two years of data covered by this study.

- Relative to PFD availability/use: It was found that PFD availability and use rates are currently very low for people involved in fatal accidents. This suggests a need for education programs and stricter enforcement of carriage requirements. The fact that a number of fatalities occurred when PFDs were available but not worn should be stressed in education programs. It was found that PFD usage in rapids or other turbulent water conditions does not appear to significantly affect survivability. However, it is likely that this finding is an artifact due to the lack of information on non-fatal accidents. In addition, the low wear rate for PFDs, coupled with low survival times and short times to rescue, all support inflatable devices (PFDs) as a potential solution for further study. These conclusions concerning canoeing also hold true for inflatables; however, insufficient fatalities per year again precluded meaningful conclusions concerning kayaks.

- Relative to education: Without rate data it could not be determined whether educated boaters actually have lower fatality rates than uneducated boaters. However, it can be seen that most victims had not been reached by formal education programs. This means that beefing up existing programs without reaching more canoeists would have limited potential. The tables in this section provide a description of a typical accident which education programs should strive to prevent in addition to descriptive information on the target population. As is shown in this report, most fatalities involve owned (not rented) vessels which are commercially manufactured. The latter information points in

the direction of possible educational material contained within the owner's manual or handed out by dealers at the time of sale. The relatively young age of most victims points to programs aimed at the younger end of the boater population, with possible emphasis on scouting programs or seminars. As can be seen from the data, the above appears to apply uniformly to canoes and inflatables. There is little reason at this point to believe that the kayak data would be different, but the small number of accidents involved and high number of unknown responses again limited the depth of kayak accident analysis.

Following are several accident scenarios that are representative, but not all-inclusive, of those that were used in this analysis.

- Several young people ages 10-16 are attending a group outing at a quiet lake where canoes are available. Four are in one canoe and suddenly it overturns. Other canoes are close by to aid. Three are rescued but one drowns immediately, never resurfacing. PFDs were available, both in the affected canoe and those close by. None were worn.
- Two young men ages 19 and 24 obtain a canoe and decide to try their luck at canoeing. Cushions are in the bottom. Neither are very good swimmers and the sun is starting to set. After about 10-15 minutes, they decided to return to their starting point. In turning, the canoe upsets. One drowns but the other grabs a cushion and makes his way to shore.
- Four people in a raft are going down a fairly swift but calm river. All are wearing PFDs. Around a bend there appears a small fall (actually 10 ft). Either they decide to jump it (believing it is only 2-3 ft) or they cannot change direction, so they go over the falls. One person is pinned under the raft and backwash and drowns. Another was last seen going down river; recovered a day later about one mile downstream. Two people make it to shore and survive.
- Two people ages 30 and 26 in a canoe are going down a swift river containing some rapids in early spring. One has had some experience in rapids but the other has only canoed in quiet lakes. Both are wearing PFDs. The canoe tips over midway through the rapids and both are separated from the canoe. One makes his way to shore and survives. The survivor last sees his partner floating down the rapids. Death reported as drowning when his body is recovered two days later.

- A man and wife are canoeing in a swift river (no rapids). The wife cannot swim very well but the husband considers himself an above average swimmer. Both are wearing PFDs. For some reason (hits submerged object?) the canoe tips over but both are able to cling to it. After about 5-10 minutes, the husband removes his PFD and attempts to swim to shore, which is only 100 feet from the canoe. He drowns and his wife, who stayed with the canoe, was later rescued.

TABLE 27. SUMMARY OF MAJOR FINDINGS

	CANOES	INFLATABLES	KAYAKS
Scope of Problem	Average 113 Fatalities per Year (for Data Base Used). Fatality rate 1.7 to 2.2 times greater than for outboard boats.	Average 43 Fatalities per Year. Rate data not available.	Average 9 Fatalities per year. Rate data not available.
Findings Relative to Flotation Regulation	Appears that some form of increased flotation may prevent 28.3% of the fatalities per year.	Flotation does not appear to be potential safety area. In only one case studied did inflatable puncture and sink.	Insufficient fatalities over two year period to draw conclusions.
Findings Relative to PFD Regulation	PFDs are not generally worn or accessible, and in many cases are not on board. Inflatable PFDs appear to warrant further consideration.	PFDs are not generally worn or accessible, and in many cases are not on board. Inflatable PFDs appear to warrant further consideration.	Insufficient fatalities over two year period to draw conclusions.
Findings Relative to Education Programs	Most victims have little experience and have not been instructed in the use of boats.	Most victims have little experience and have not been instructed in the use of boats.	Insufficient fatalities over two year period to draw conclusions.

TABLE 28. EDUCATIONAL CONSIDERATIONS - CANOES

• Most victims for which education history was known had not had formal boating education		(79%)*
• Any new education program should pay particular attention to the following:		
TARGET:	Boat privately owned	(77%)
	as opposed to rented	(23%)
	Boat not homemade	(88%)
	Fatal victim young ≤ 26 yrs	(73%)
	Fatal victim inexperienced (under 100 hrs)	(79%)
	Fatal victim male	(92%)
TYPE ACTIVITY:	Still and slow water	(52%)
	Fast water, rapids, dams, falls	(48%)
ACCIDENT SCENARIOS TO BE PREVENTED:	Water temperature ≤ 60°	(33%)
	2 or 1 POB	(68%)
	No or insufficient PFDs on board	(45%)
	If in still or slow water:	
	- Does not lose contact with boat initially	(20%)
	- Loses contact in no to light wind	(20%)
	- Additional in no to light wind	(14%)
	Sudden drownings	(13%)
	Dies within five minutes (including sudden drowning)	(86%)
	Victim rescued within five minutes (% of total survivors)	(96%)

* All percentages given are for persons involved in fatal accidents and assume unknowns are distributed as knowns. Section 4 notes some important constraints this places on the resulting data.

TABLE 29. PFD USAGE CONSIDERATIONS - CANOES

- RELATIVE TO PFD PERFORMANCE: *
  - Survival rate in still water and slow currents are affected by PFD usage.
  - Survival rate in fast and white water unaffected by PFD usage.
  - As only 15% of the fatalities survived more than five minutes, and 96% of the survivors were rescued within five minutes, it would appear that successful devices -
    i) must be fast-acting and worn
    ii) need not provide flotation for long periods of time.
- RELATIVE TO ENFORCEMENT OF CARRIAGE REGULATIONS:
  - In 45% of fatal accidents an insufficient number of PFDs were available.

* All percentages given are for persons involved in fatal accidents and assume unknowns are distributed as knowns. Section 4 notes some important constraints this places on the resulting data.

TABLE 30. VESSEL FLOTATION CONSIDERATIONS - CANOES

- 28% of canoe accidents contain elements which indicate high probability of prevention if increased vessel flotation were present.
  - Victim maintained contact with boat or survived long enough to return to boat
  - Calm water, slow or no current
  - Light or no wind (to blow canoe out of reach)
- Above figure is in line with early estimates of fatality reduction for boats less than twenty feet in length
- Fatality rate for canoes is approximately twice that for outboards
- If canoe flotation costs no more than outboard flotation, canoe cost/benefit may exceed that for outboards by factor of two.

TABLE 31. EDUCATIONAL CONSIDERATIONS - INFLATABLES

• Most victims for whom education history was known had not received formal instruction		(96.9%)*
• Education program should pay particular attention to the following:		
TARGET:	Boat privately owned	(98.5%)
	Boat not homemade	(100%)
	Fatal victim young (≤26 yrs)	(77%)
	Fatal victim male	(93%)
TYPE ACTIVITY:	Rapids, fast water, falls or dams	(85%)
ACCIDENT SCENARIOS TO BE PREVENTED:	None to moderate wind	(89%)
	Water temperature ≤ 60°	(33%)
	2 or 1 POB	(69%)
	Insufficient number of PFDs on board	(75%)
	Boat inaccessible after accident	(63%)
	Victim drowns within five minutes	(97%)
	Survivor rescued within five minutes	(84%)
	Accident occurs within 100 ft of shore	(82%)

* All percentages given are for persons involved in fatal accidents and assume unknowns are distributed as knowns. Section 4 notes some important constraints this places on the resulting data.

TABLE 32. PFD USAGE CONSIDERATIONS - INFLATABLES

- As only 3% of the fatalities survived more than five minutes, and 84% of the survivors were rescued within five minutes, it would appear that successful devices:
  - Must be fast-acting and worn
  - Need not provide flotation for long periods of time.
- As flotation shows little promise, PFDs are the primary remaining recovery aid.
- Relative to enforcement of carriage regulations:
  - In 75% of the fatal accidents an insufficient number of PFDs were available.

TABLE 33. VESSEL FLOTATION CONSIDERATIONS - INFLATABLES

- Inflatable punctured only in one case.
- Inflatables have inherent flotation if not punctured.
- No apparent premise for flotation modification for inflatables.

REFERENCES

1. Effectiveness of a Proposed Level Flotation Standard by USCG Headquarters Marine Technology Department. Draft Report, 24 October 1975.

2. Wulfsberg, Rolf M. and Darryl A. Lang, Recreational Boating in the Continental United States in 1973: The Nationwide Boating Survey, USCG Final Report. October 1974. NTIS #AD-A000 471.

3. Doll, T., et al, Personal Flotation Devices Research - Phase I, Final Report to USCG. Contract DOT-CG-42333-A. July 1976.

4. Sautkulis, C. and Bowman, J., Preliminary Evaluation of the Loading, Powering and Flotation of a Sample of Canoes, Technical Brief 74-11 to USCG. Contract No. DOT-CG-40672-A. December 1974.

5. Kissinger, J. R., An Analysis of 1974 Fatal Boating Accidents - Predicting the Effectiveness of a Level Flotation Standard, USCG Final Report, April 1976.

APPENDIX A.

CODING INSTRUCTIONS FOR CANOE, KAYAK AND INFLATABLE CRAFT ACCIDENTS

1. Accident Identification Number -- USCG case number or Wyle accident number. If case number is unknown, assign number starting with 00100.

2. Number of person involved in accident.

3. Coder -- Use coder number assigned.

4. State -- Use GSA code list.

5. Month -- Jan. (01); Feb. (02); etc.

6. Year -- last two digits

7. Time of day -- 24 hour clock to nearest hour when known. Otherwise,

   Midnight to Sunrise (25)
   Sunrise to Noon (26)
   Noon to Sunset (27)
   Sunset to midnight (28)

8. Accident Type --

   (1) Capsizing
   (2) Swamping
   (3) Fall Overboard
   *(4) Collision
   (5) Jump Overboard

   Swamping includes swamping leading to capsizing, floodings, sinkings.

   * Use collision only when it does not lead to one of the other categories.

9. Boat Type

   (1) Canoe, open
   (2) Canoe, decked
   (3) Kayak
   (4) Inflatable canoe
   (5) Inflatable raft
   (6) Raft using inflated inner tubes as flotation
   (7) Raft using barrels as flotation
   (8) Raft, all other types

   Assume canoe is open type if not stated otherwise.

10. Persons On Board -- Code total number. If more than one boat is included in the same case, code total number of persons on both boats.

11. Occupants Age -- Code number of years.

12. Occupants Sex --

    (1) Male
    (2) Female

13. Formal Boating Instruction (General)

    (1) Yes
    (2) No

14. Formal Boating Instruction (Canoe)

    (1) Yes
    (2) No

    NOTE: For 12 and 13 above, classify various courses using best judgment.

15. Rented Boat

    (1) Yes
    (2) No

16. Homemade Boat

    (1) Yes
    (2) No

17. Boat Length -- Nearest foot

18. Boat Material --

    (1) Wood
    (2) Aluminum
    (3) Fiberglass (includes plastic)
    (4) Ferrocement
    *(5) Rubber
    (6) Other

19. Horsepower On Board -- Code nearest whole number (Example: 7-1/2; Code 08)

20. Participating in Contest

    (1) Yes
    (2) No

21. Occupants Boating Experience (Total)

(1) Less than 20 hrs.
(2) 20-100 hrs.
(3) 100-500 hrs.
(4) Greater than 500 hrs.

22. Occupants Boating Experience (Canoe)

(1) Less than 20 hrs.
(2) 20-100 hrs.
(3) 100-500 hrs.
(4) Greater than 500 hrs.

NOTE: For 20 and 21 above, if report has only "experience" given, assume it is total boating experience and code canoe experience as unknown.

23. Body of Water

(1) River, creek
(2) Lake, pond (other than Great Lakes)
(3) Great Lakes
(4) Coastal bay, inlet, canal, harbor, etc.
(5) Ocean

24. Type of Water

(1) Still
(2) Slow
(3) Fast
(4) Rapids
(5) Falls
(6) Dam

NOTE: Code where accident occurred.

25. Distance from shore - in increments of 50 ft

26. Wind

(1) None
(2) Light (0-6 mph)
(3) Moderate (7-14 mph)
(4) Strong (15-25 mph)
(5) Storm (over 25 mph)

27. Water Conditions

    (1) Calm
    (2) Choppy
    (3) Rough
    (4) Rapids, falls, dams

28. Water temperature -- Degrees Fahrenheit if known. Otherwise, code

    (96) Not relevant
    (97) Cold
    (98) Very cold (nearly freezing)

29. Air Temperature -- Degrees Fahrenheit. If unknown,

    (95) Very cold
    (96) Cold
    (97) Warm
    (98) Very warm

30. Time out before accident -- code nearest 10th hour if known (example: 15 min., code 02; one hour, code 10). For others not known exactly, code as follows:

    * (96) a short while
    * (97) about an hour or so
    * (98) several hours

31. Cause of Accident -- Number of block at end of Event Tree 1.

32. Final Boat Condition -- Number of block at end of Event Tree 2.

33. Occupants' Behavior -- Number of block at end of Event Tree 3. Assume person maintains contact unless there is evidence to the contrary.

34. PFDs On Board -- Total number of PFDs on board.

35. PFD Availability/Use -- Number of block at end of Event Tree 4.

36. Time Until PFD Used/Removed -- Number of minutes used applies only to Block 4 and 5 of Event Tree 4. Removed applies only to Block 3 of Event Tree 4. Otherwise, code as 98 (not applicable).

37. PFD Type -- Number of block at end of Event Tree 5.

38. PFD Malfunction --

(1) Yes
(2) No
(3) Not applicable

Code as (2) unless there is some indication that PFD may not have functioned properly. If person drowned and PFD malfunctioning not mentioned in BAR, code 9.

Code as (3) if there were no PFDs on board or if it was unknown whether any PFDs were on board.

39. Improper PFD Use

(1) Yes
(2) No
(3) Not applicable

Code as (3) if there were no PFDs on board or if it was unknown whether any PFDs were on board.

40. Victims' Condition -- Number of block at end of Event Tree 6.

41. Health

(1) Good
(2) History of heart trouble
(3) Other poor health

Assume good health unless indicated otherwise.

42. Time From Accident to Drowning/Rescue -- number of minutes. Code as 01 for a Sudden Drowning.

43. Distress Notification -- Number of block at end of Event Tree 7.

44. Alcohol Involved -

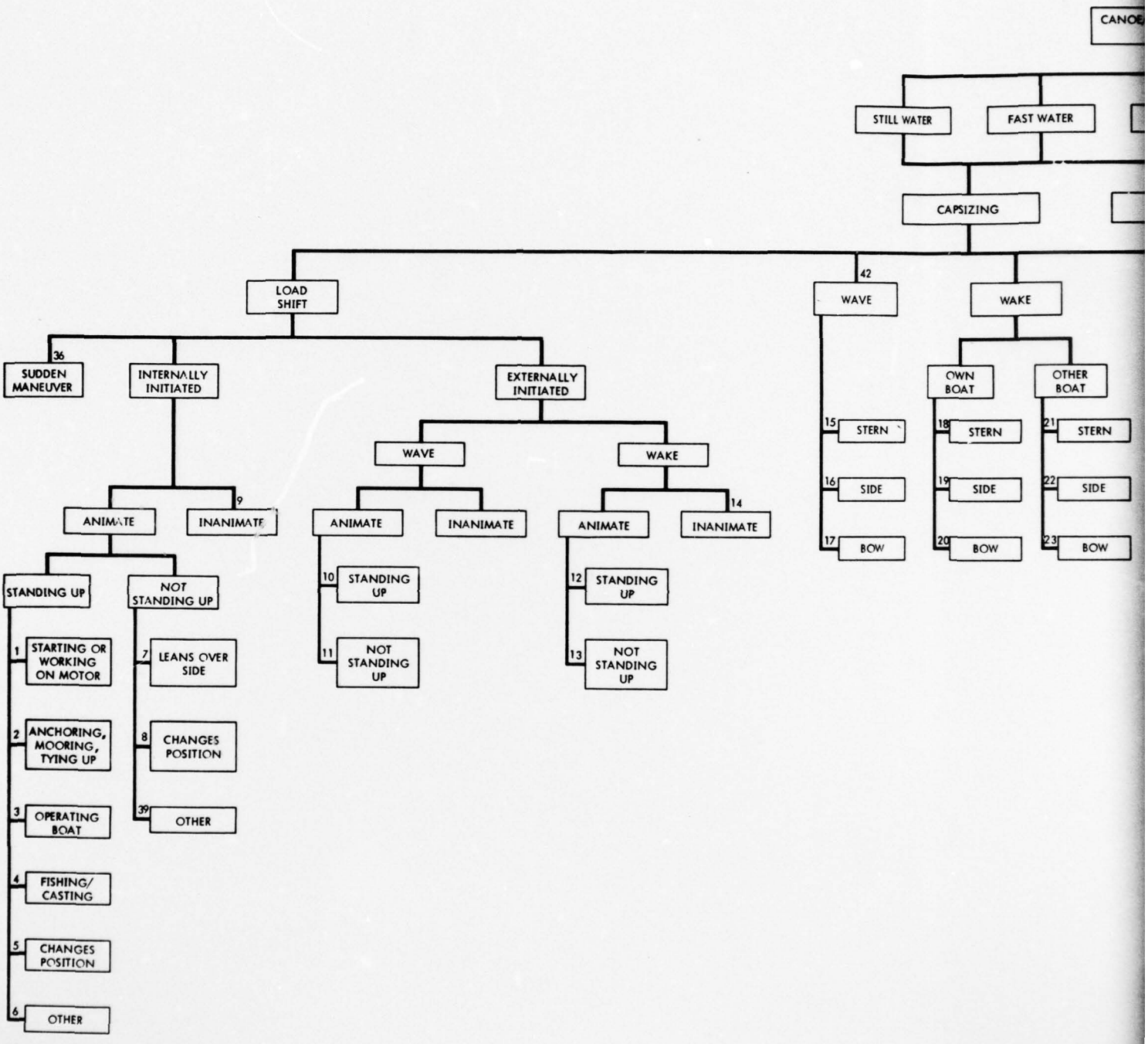
(1) Yes
(2) No

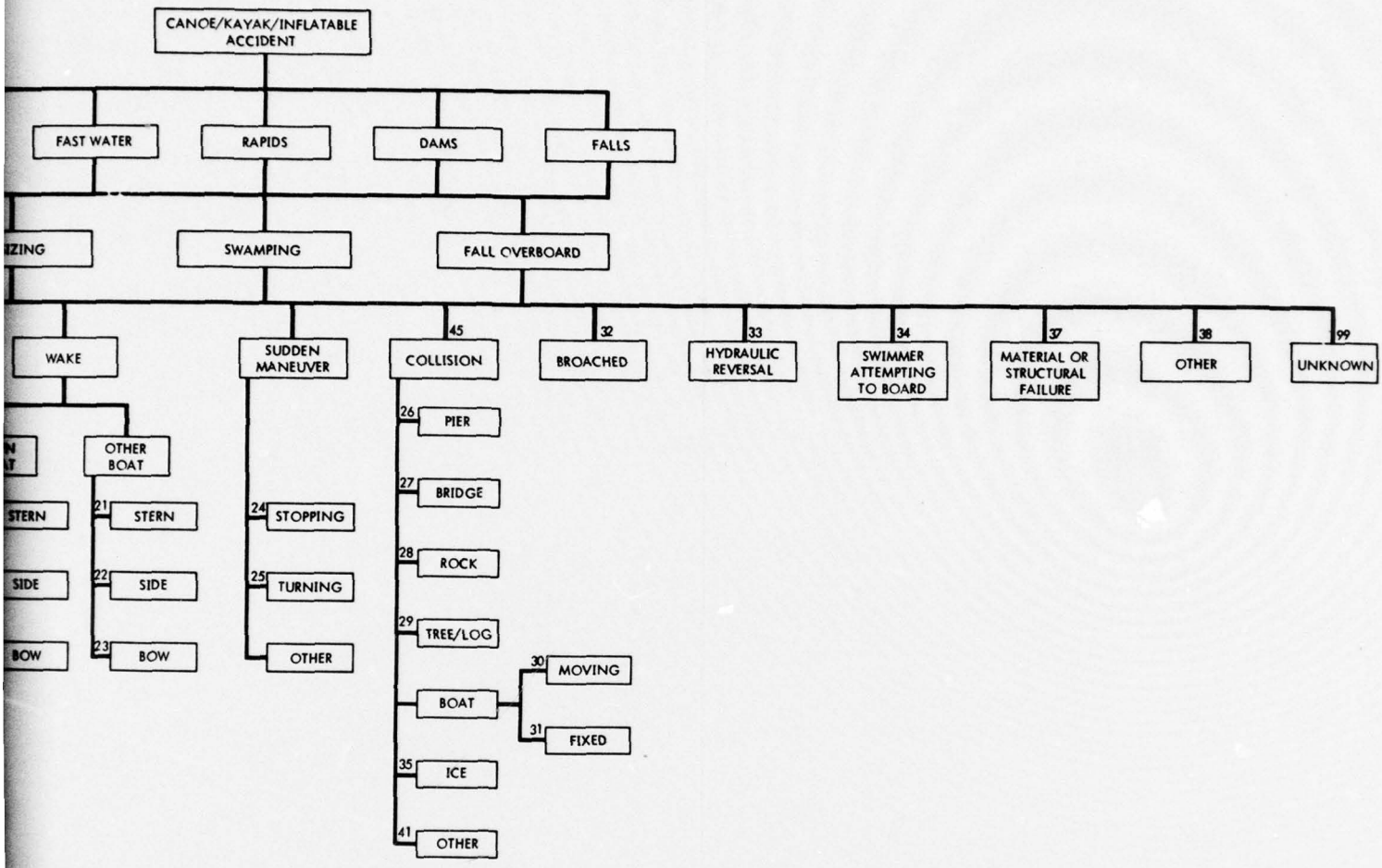
Code (1) only if such is indicated in the case report. Otherwise, code as (2).

45. Number of Boats Involved -- Code number of boats.

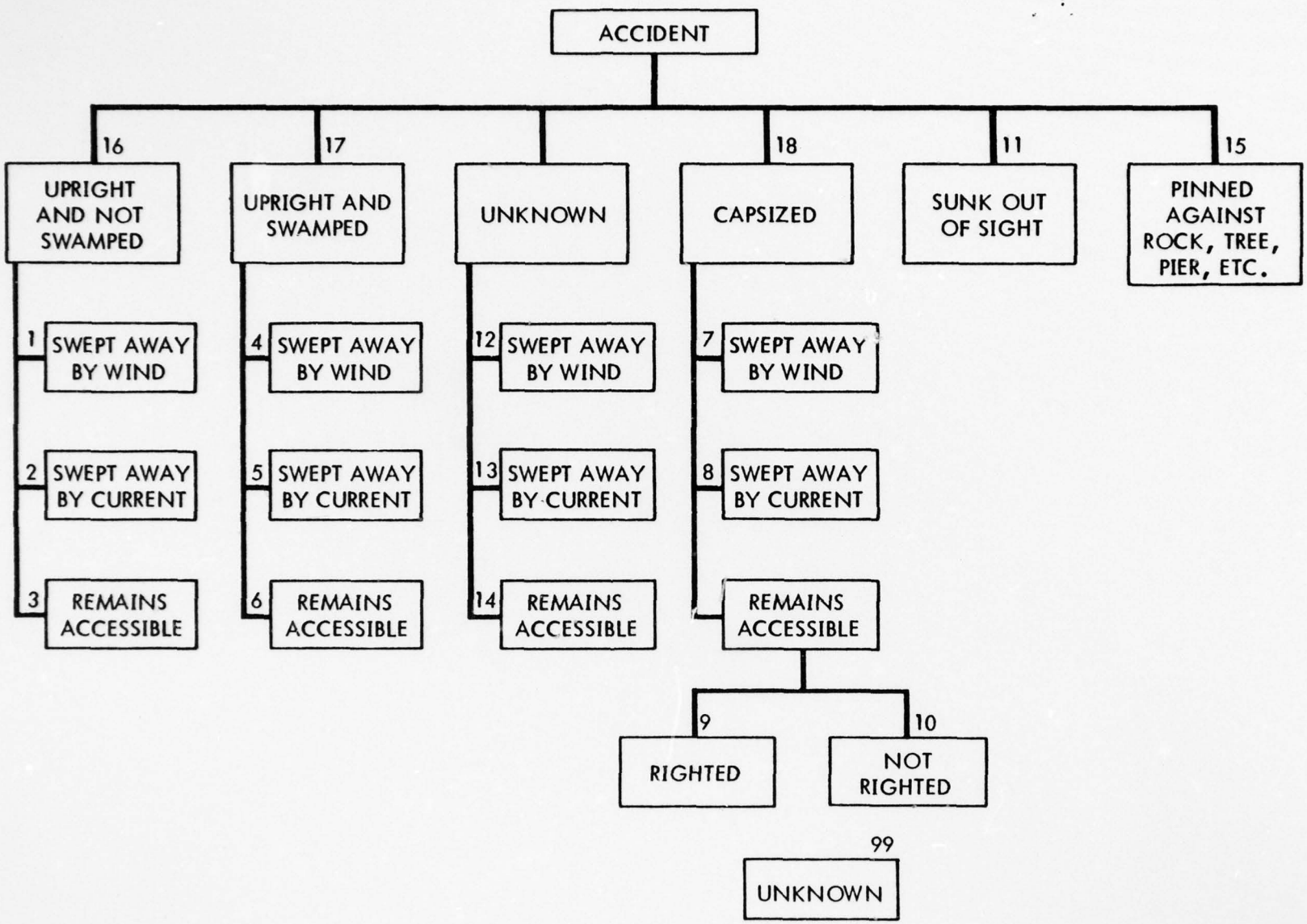
46. Contributing Factors to Accident -- Code only the primary contributing factor as follows:

(1) Flood swollen waters
(2) Horseplay (excessive and unnecessary)
(3) Unfamiliar waters
(4) Over-confidence
(5) Other
(6) None
(9) Unknown


CANOE
STILL WATER
FAST WATER
CAPSIZING
LOAD SHIFT
42
WAVE
WAKE
36
SUDDEN MANEUVER
INTERNALLY INITIATED
EXTERNALLY INITIATED
OWN BOAT
OTHER BOAT
15
STERN
16
SIDE
17
BOW
18
STERN
19
SIDE
20
BOW
21
STERN
22
SIDE
23
BOW
WAVE
WAKE
9
ANIMATE
INANIMATE
ANIMATE
INANIMATE
ANIMATE
14
INANIMATE
STANDING UP
NOT STANDING UP
10
STANDING UP
11
NOT STANDING UP
12
STANDING UP
13
NOT STANDING UP
1
STARTING OR WORKING ON MOTOR
2
ANCHORING, MOORING, TYING UP
3
OPERATING BOAT
4
FISHING/ CASTING
5
CHANGES POSITION
6
OTHER
7
LEANS OVER SIDE
8
CHANGES POSITION
39
OTHER



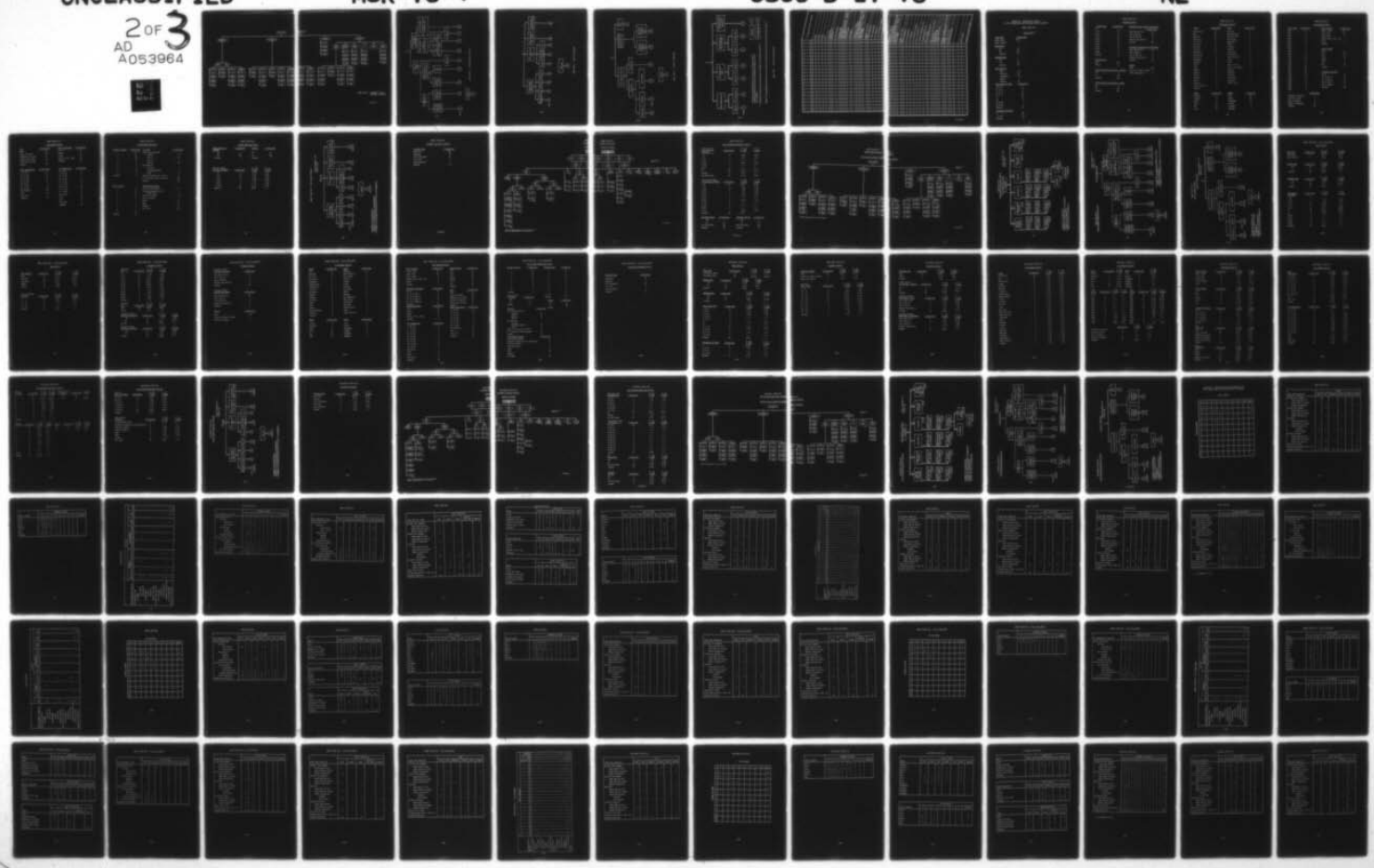
EVENT TREE 1. CAUSE OF ACCIDENT



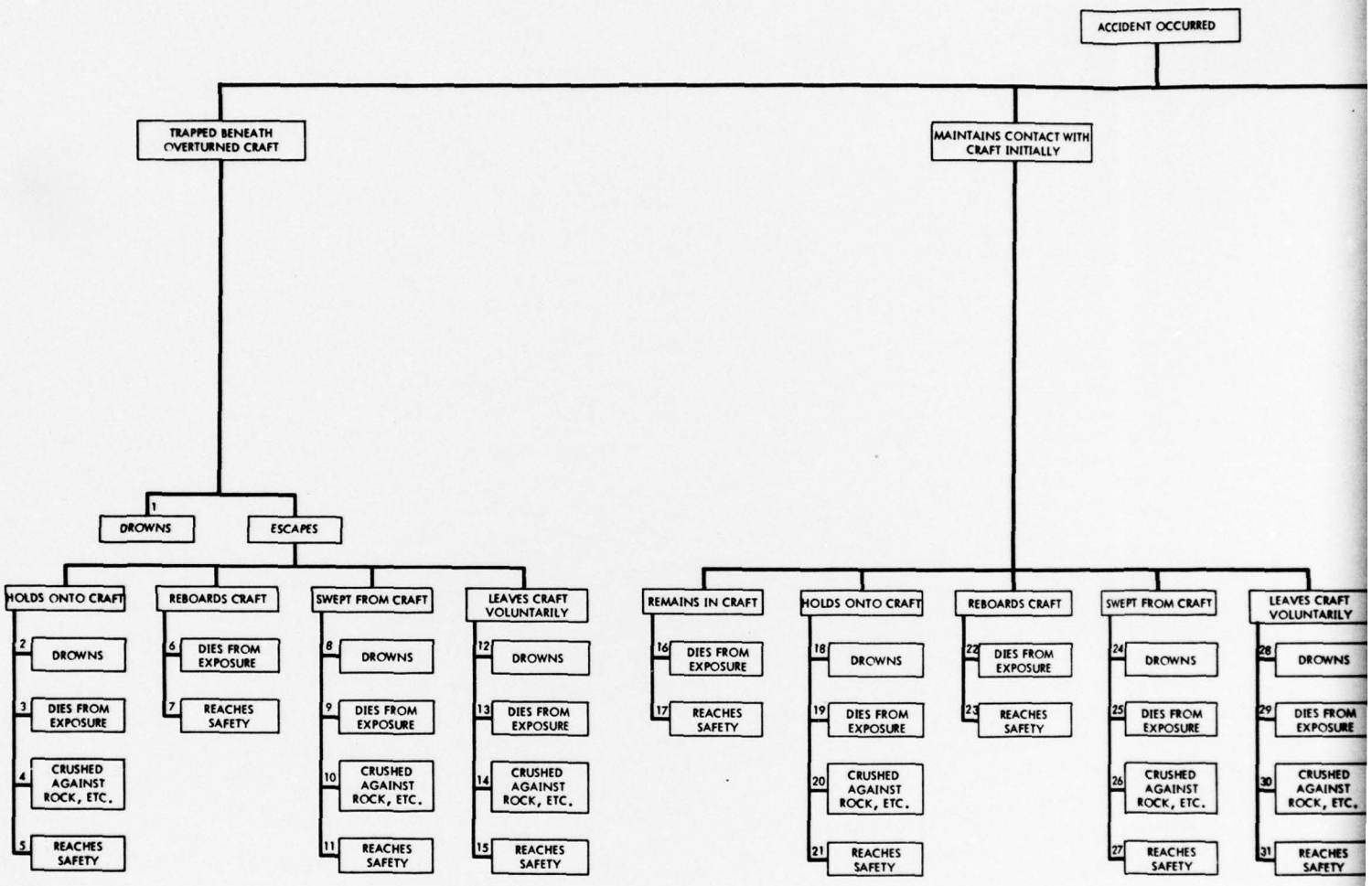
EVENT TREE 2. FINAL CONDITION OF CRAFT

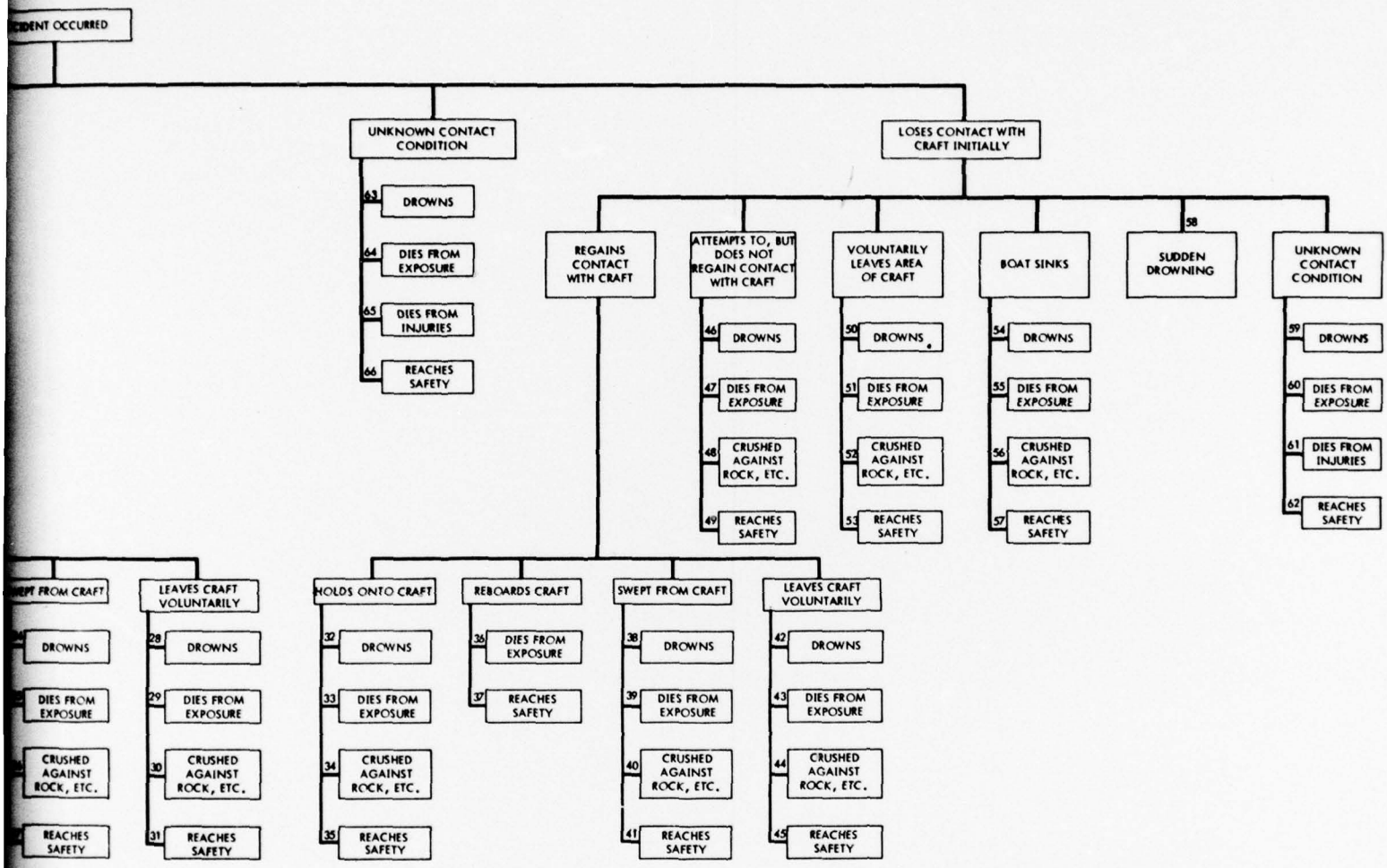
AD-A053 964 WYLE LABS HUNTSVILLE ALA F/G 13/12
CAUSE IDENTIFICATION ANALYSIS OF FATAL ACCIDENT DATA FOR CANOES--ETC(U)
FEB 78 C SAUTKULIS, R DOUGLAS, K GEISSLER DOT-CG-40672-A
UNCLASSIFIED MSR-78-4 USCG-D-17-78 NL

2 OF 3
AD
A053964

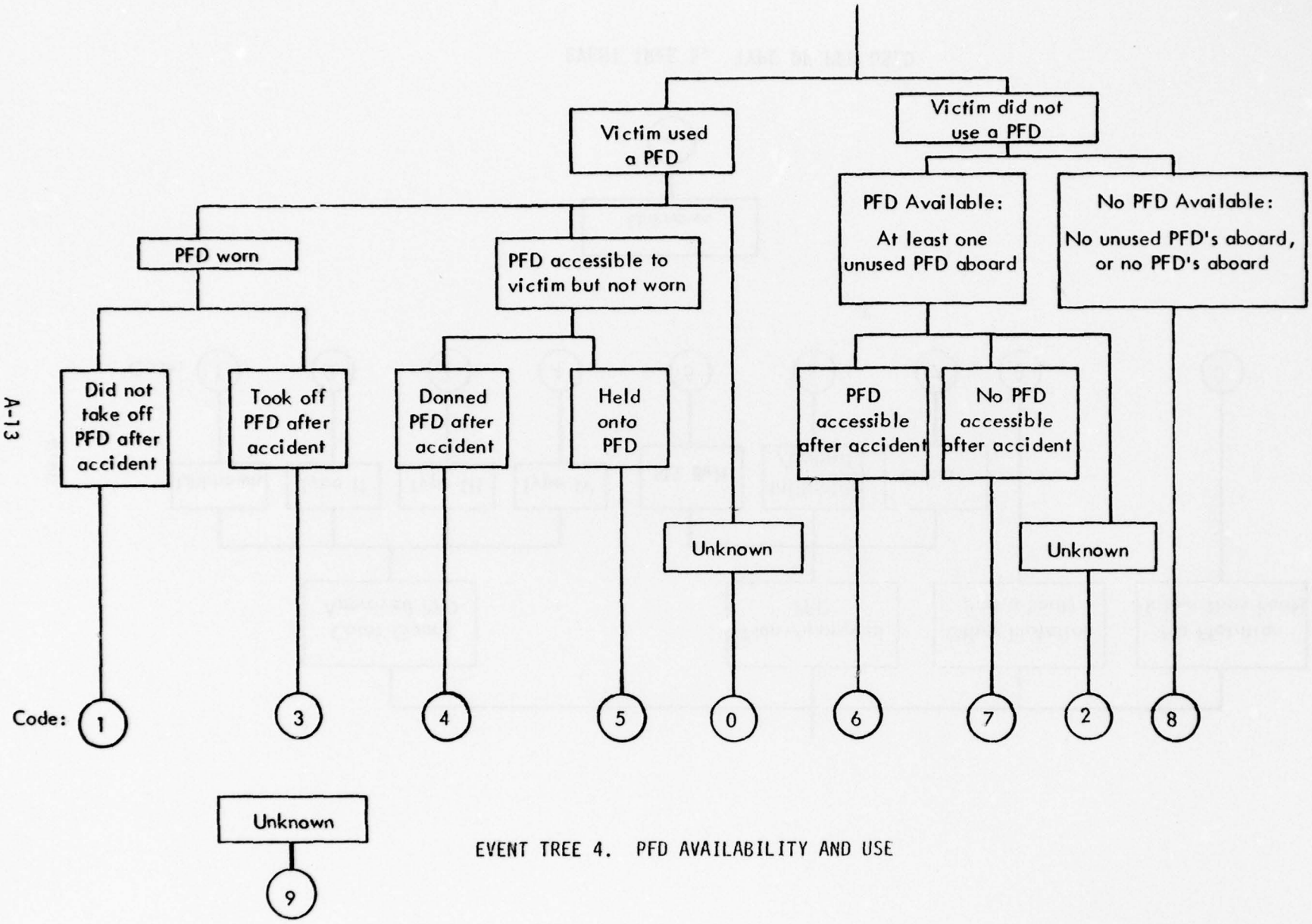



OF
3
3964

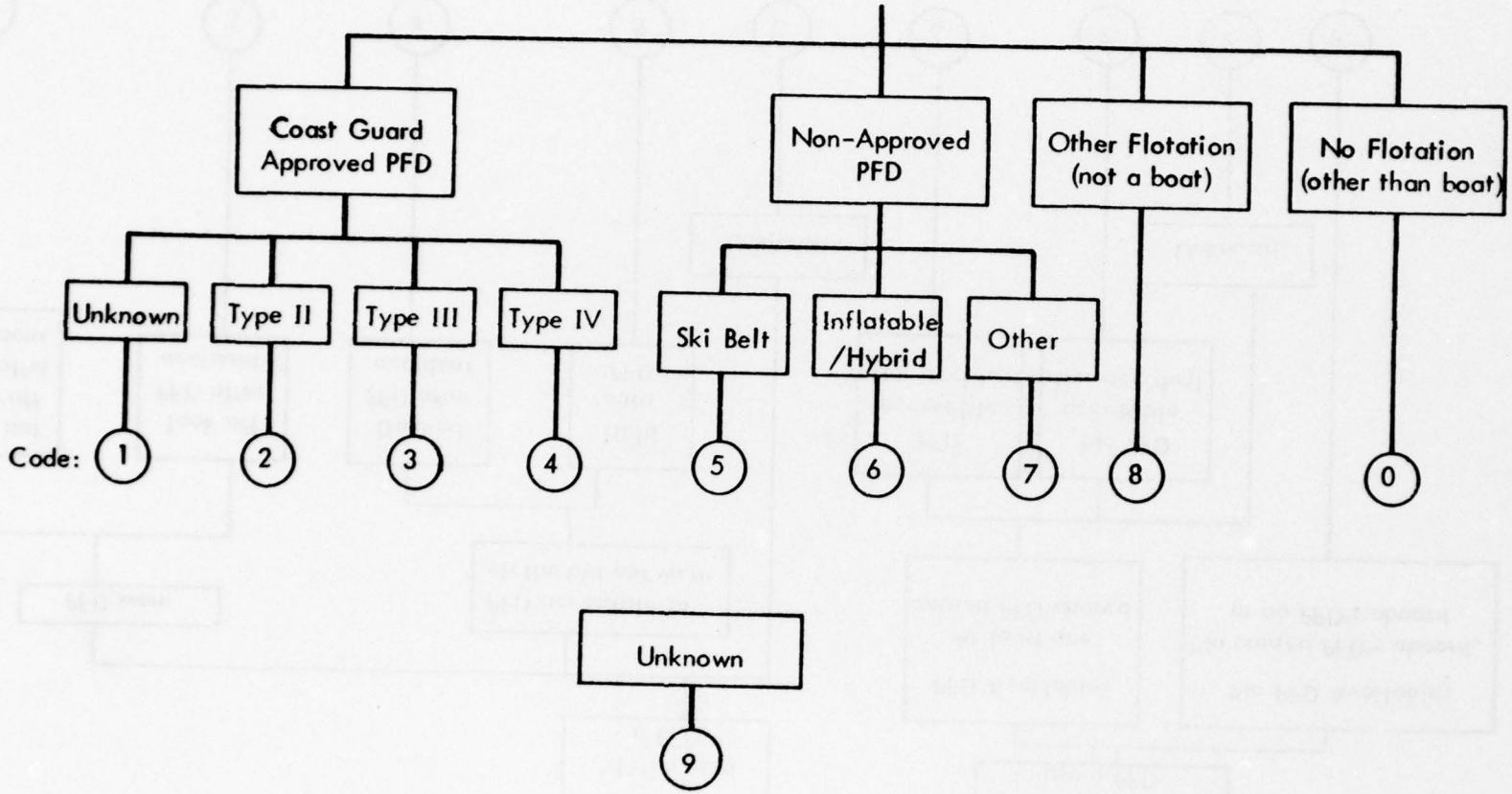

ACCIDENT OCCURRED
TRAPPED BENEATH OVERTURNED CRAFT
MAINTAINS CONTACT WITH CRAFT INITIALLY
1
DROWNS
ESCAPES
HOLDS ONTO CRAFT
REBOARDS CRAFT
SWEPT FROM CRAFT
LEAVES CRAFT VOLUNTARILY
2 DROWNS
3 DIES FROM EXPOSURE
4 CRUSHED AGAINST ROCK, ETC.
5 REACHES SAFETY
6 DIES FROM EXPOSURE
7 REACHES SAFETY
8 DROWNS
9 DIES FROM EXPOSURE
10 CRUSHED AGAINST ROCK, ETC.
11 REACHES SAFETY
12 DROWNS
13 DIES FROM EXPOSURE
14 CRUSHED AGAINST ROCK, ETC.
15 REACHES SAFETY
REMAINS IN CRAFT
HOLDS ONTO CRAFT
REBOARDS CRAFT
SWEPT FROM CRAFT
LEAVES CRAFT VOLUNTARILY
16 DIES FROM EXPOSURE
17 REACHES SAFETY
18 DROWNS
19 DIES FROM EXPOSURE
20 CRUSHED AGAINST ROCK, ETC.
21 REACHES SAFETY
22 DIES FROM EXPOSURE
23 REACHES SAFETY
24 DROWNS
25 DIES FROM EXPOSURE
26 CRUSHED AGAINST ROCK, ETC.
27 REACHES SAFETY
28 DROWNS
29 DIES FROM EXPOSURE
30 CRUSHED AGAINST ROCK, ETC.
31 REACHES SAFETY



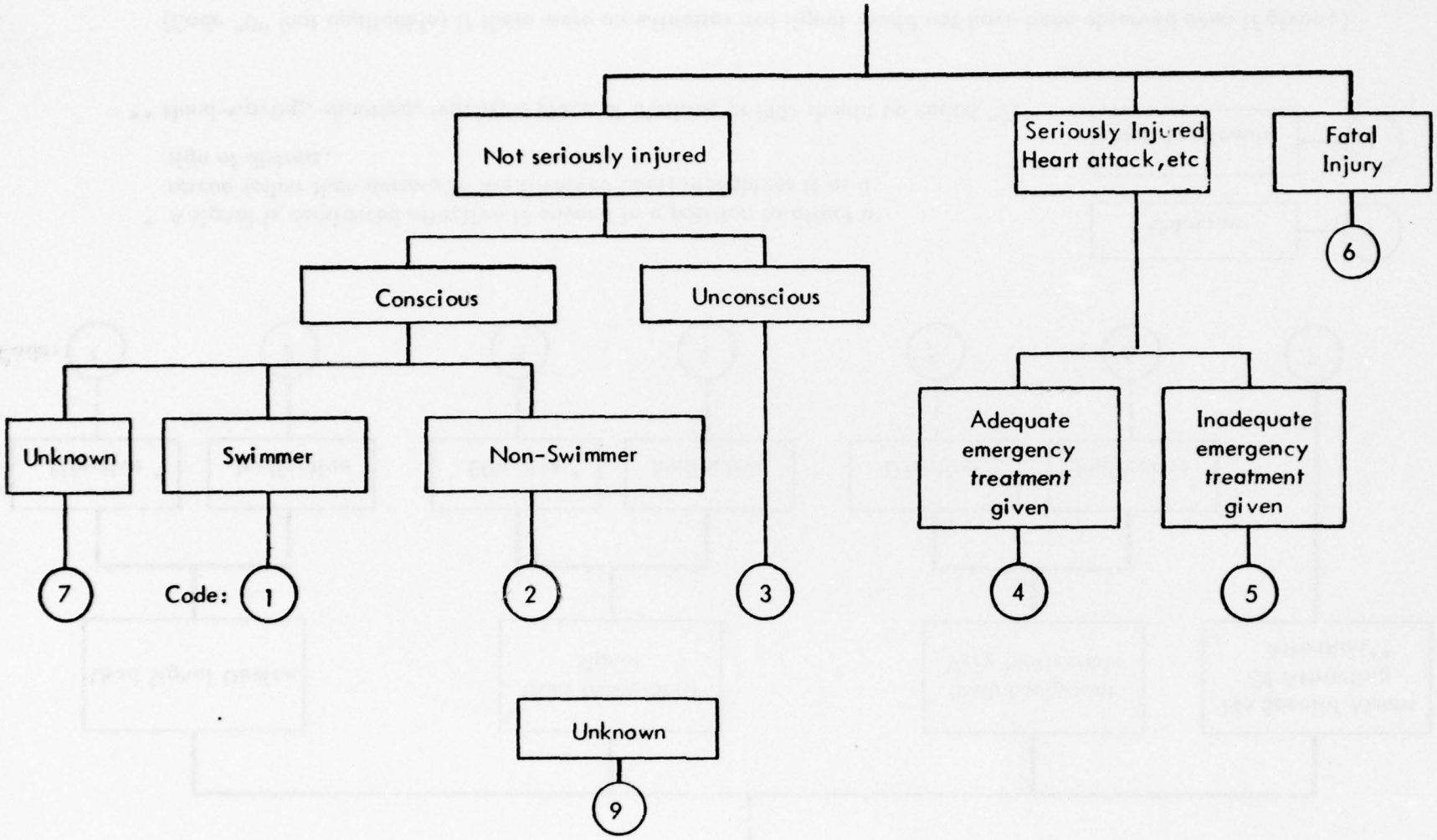
EVENT TREE 3. OCCUPANTS' POST-ACCIDENT SITUATION



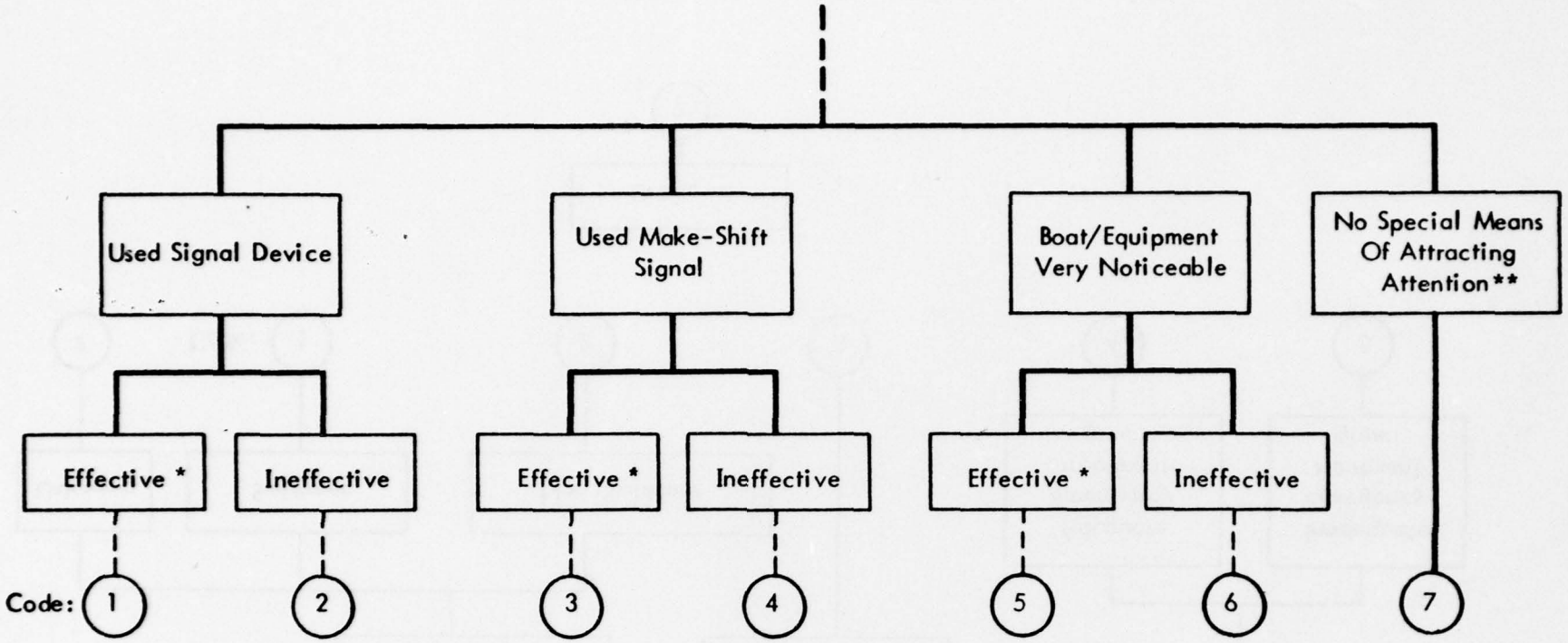
EVENT TREE 4. PFD AVAILABILITY AND USE



EVENT TREE 5. TYPE OF PFD USED



EVENT TREE 6. VICTIMS' CONDITION



* A signal is considered effective if anyone in a position to affect a rescue (other than persons in the involved boat) recognizes it as a sign of distress.

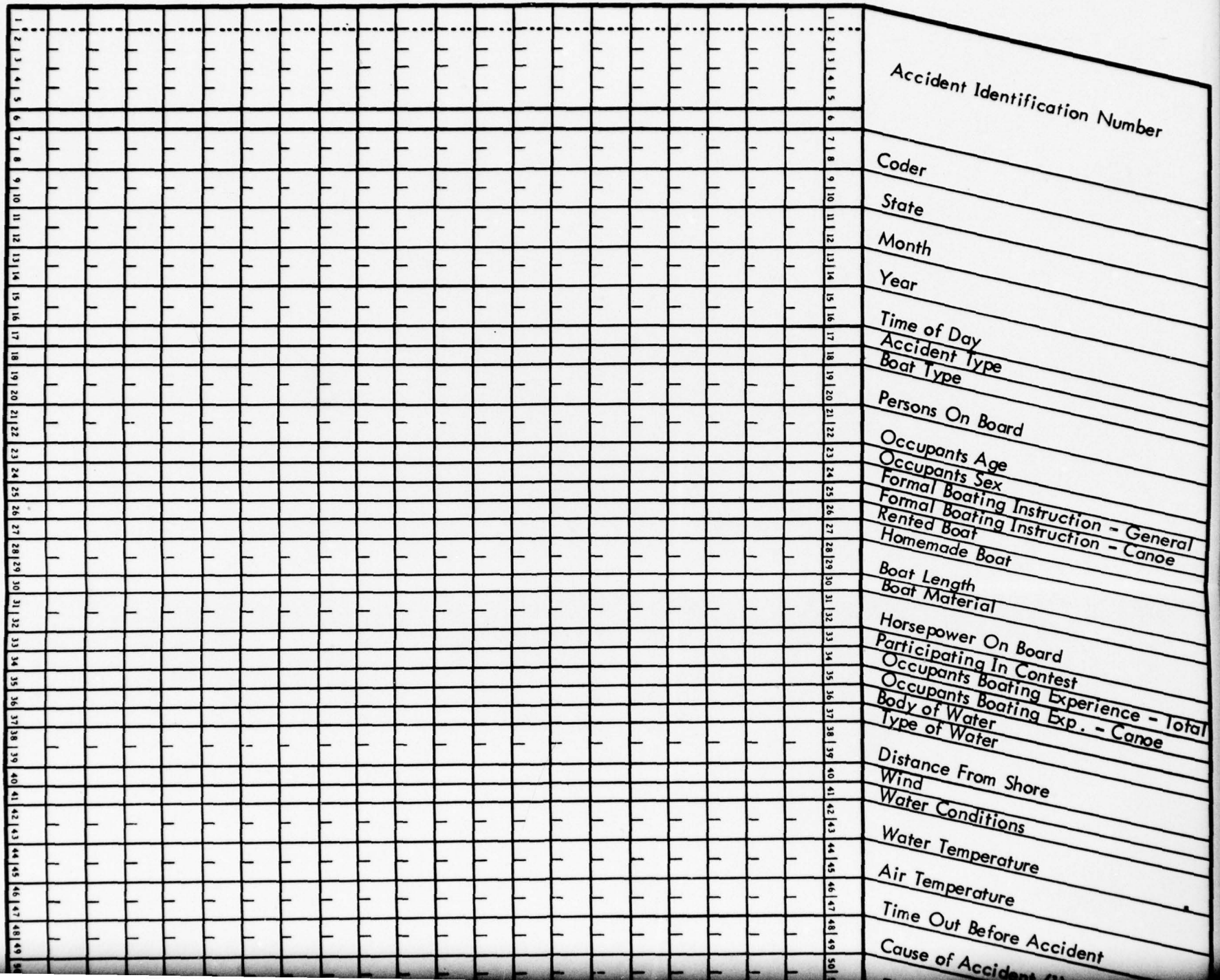
** Hand-waving, shouting, waving a piece of clothing or PFD should be coded "7."

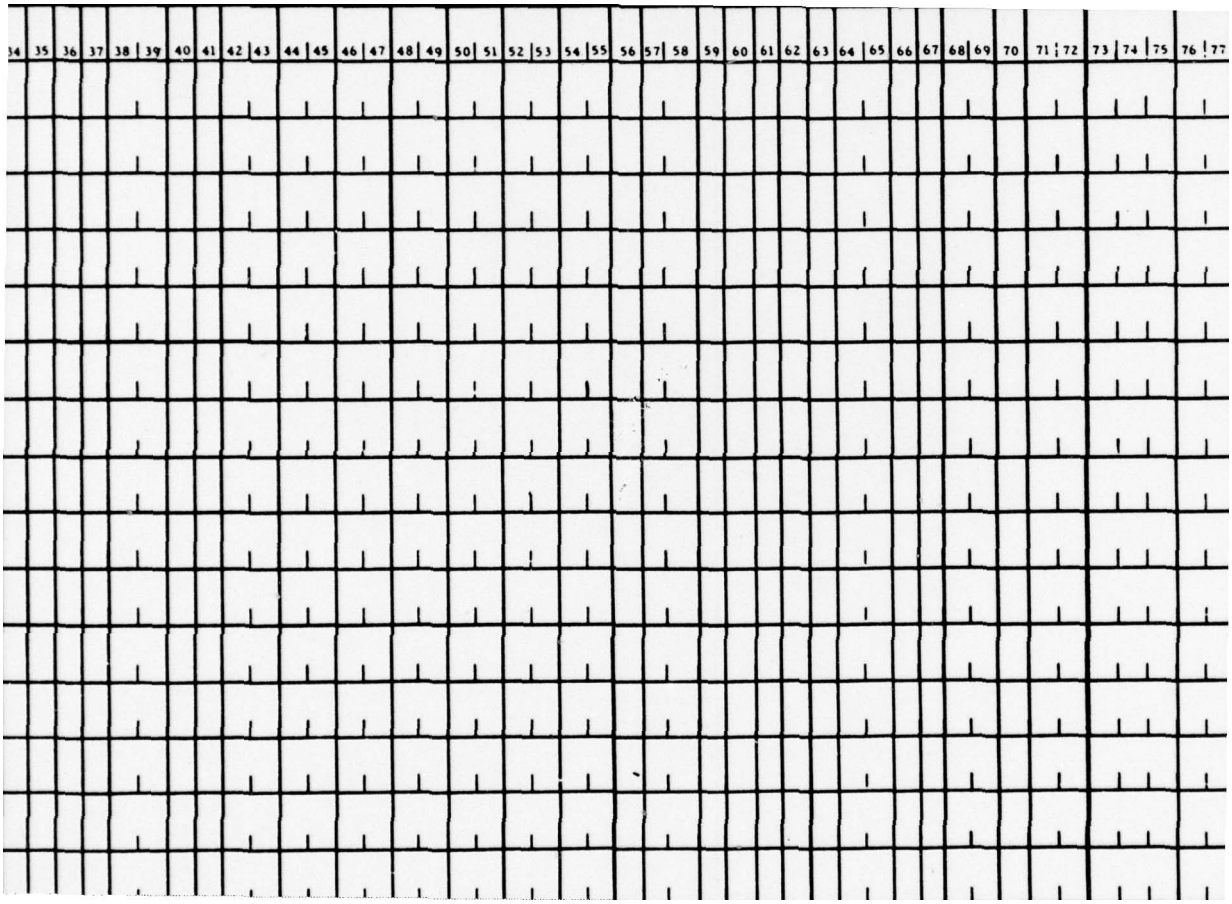
Unknown — 9

Not Applicable — 0

(Code "0" (not applicable) if there were no witnesses and signal would not have been observed even if given.)

EVENT TREE 7. DISTRESS NOTIFICATION


Accident Identification Number
Coder
State
Month
Year
Time of Day
Accident Type
Boat Type
Persons On Board
Occupants Age
Occupants Sex
Formal Boating Instruction - General
Formal Boating Instruction - Canoe
Rented Boat
Homemade Boat
Boat Length
Boat Material
Horsepower On Board
Participating In Contest
Occupants Boating Experience - Total
Occupants Boating Exp. - Canoe
Body of Water
Type of Water
Distance From Shore
Wind
Water Conditions
Water Temperature
Air Temperature
Time Out Before Accident
Cause of Accident


34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77

APPENDIX B. DESCRIPTIVE PROFILES OF FATAL CANOE/KAYAK AND INFLATABLE CRAFT ACCIDENTS

CANOE FATALITIES

Boat Profile

Boat Type	# Fatalities
Canoe, open	225
Canoe, Decked	1
Rented Boat	
Yes	39
No	133
Unknown	54
Homemade Boat	
Yes	17
No	121
Unknown	88
Boat Material	
Wood	15
Aluminum	128
Fiberglass	42
Rubber	3
Unknown	38

Boat Length In Feet	# Fatalities
9 to 10	2
11 to 12	16
13 to 14	32
15 to 16	59
17	54
18	5
19 to 20	1
26 to 30	1
Unknown	56
Horsepower On Board	
0	180
1 to 10	15
Unknown	31

CANOE FATALITIES

Occupant Profile

Occupant Age	# Fatalities
0-9	3
10-15	17
16-18	37
19-21	37
22-26	60
27-30	21
31-39	16
40-49	10
50-59	8
60-98	3
Unknown	14

Occupants Sex	
Male	207
Female	19

Formal Boating Instruction - General	
Yes	5
No	56
Unknown	165

Formal Boating Instruction - Canoe	
Yes	5
No	56
Unknown	165

Occupants Total Boating Experience	# Fatalities
Less than 20 hrs	33
20 to 100 hrs	12
100 to 500 hrs	3
Greater than 500 hrs	9
Unknown	169

Occupants Canoe Boating Experience	
Less than 20 hrs	35
20 to 100 hrs	7
100 to 500 hrs	5
Greater than 500 hrs	7
Unknown	172

Health	
Good	221
History of heart trouble	3
Other poor health	2

CANOE FATALITIES

Environment Profile

STATE	# Fatalities	STATE	# Fatalities
Pennsylvania	20	Colorado	3
Ohio	19	Massachusetts	3
New York	18	New Hampshire	3
Wisconsin	12	New Jersey	3
California	11	Washington	3
Illinois	11	Alaska	2
Michigan	10	Arkansas	2
Virginia	10	Indiana	2
Minnesota	8	Louisiana	2
Connecticut	6	Mississippi	2
Missouri	6	South Carolina	2
Tennessee	6	Texas	2
Alabama	5	Utah	2
Idaho	5	West Virginia	2
Iowa	5	Dist. of Columbia	1
Oregon	5	Georgia	1
Wyoming	5	Maryland	1
Kansas	4	Nebraska	1
Kentucky	4	New Mexico	1
Maine	4	Oklahoma	1
Montana	4	Rhode Island	1
North Carolina	4		
Vermont	4		

MONTH	# Fatalities	MONTH	# Fatalities
January	5	July	23
February	4	August	20
March	24	September	10
April	31	October	12
May	49	November	7
June	38	December	3

CANOE FATALITIES

Environment Profile

Time of Day	# Fatalities
2400	0
0100	0
0200	1
0300	0
0400	4
0500	0
0600	0
0700	1
0800	7
0900	3
1000	10
1100	14
1200	14
1300	9
1400	16
1500	24
1600	36
1700	14
1800	19
1900	5
2000	10
2100	2
2200	2
2300	3

Body of Water	# Fatalities
River, creek	132
Lake, Pond	82
Great Lakes	4
Coastal Bay, inlet, etc.	5
Ocean	0
Unknown	3

Type of Water	
Still	87
Slow	25
Fast	43
Rapids	27
Falls	4
Dam	30
Unknown	10

Distance From Shore	
50 ft	51
51 to 100 ft	19
101 to 250 ft	12
251 to 500 ft	15
501 to 4900 ft	11
Unknown	118

	# Fatalities
Midnight to Sunrise	1
Sunrise to Noon	1
Noon to Sunset	4
Sunset to Midnight	0
Unknown	26

CANOE FATALITIES

Environment Profile

Wind	# Fatalities
None	40
Light (0-6 mph)	83
Moderate (7-14 mph)	28
Strong (15-25 mph)	23
Storm (over 25 mph)	3
Unknown	49

Water Conditions	# Fatalities
Calm	71
Choppy	15
Rough	45
Rapids, falls, dams	62
Unknown	33

Water Temperature	# Fatalities
1° to 30°	0
31° to 40°	26
41° to 50°	17
51° to 60°	12
61° to 70°	15
71° to 80°	8
81° to 95°	2
Not Relevant	25
Cold	53
Very Cold	7
Unknown	61

Air Temperature	# Fatalities
1° to 10°	0
11° to 20°	0
21° to 30°	1
31° to 40°	10
41° to 50°	15
51° to 60°	9
61° to 70°	18
71° to 80°	17
81° to 94°	14
Very Cold	4
Cold	12
Warm	26
Very Warm	2
Unknown	98

CANOE FATALITIES

Pre-Accident Operations

Persons on Board	# Fatalities
1	30
2	124
3	45
4	17
5	7
6	0
7	0
8	0
9	3
Unknown	0

PFDs on Board	
0	72
1	12
2	77
3	21
4	7
5	1
6	1
7	0
8	0
9	0
Unknown	35

PFD Type	# Fatalities
Coast Guard Approved	
Unknown	75
Type II	13
Type III	3
Type IV	16
Not Approved	
Ski Belt	1
Inflatable/Hybrid	1
Other	0
Other Flotation (not a boat)	3
No Flotation (other than boat)	80
Unknown	34

Contributing Factors	
Flood swollen waters	23
Horseplay (Excessive and unnecessary)	5
Unfamiliar Waters	6
Over-confidence	7
Other	19
None	23
Unknown	15
Not Coded	128

CANOE FATALITIES

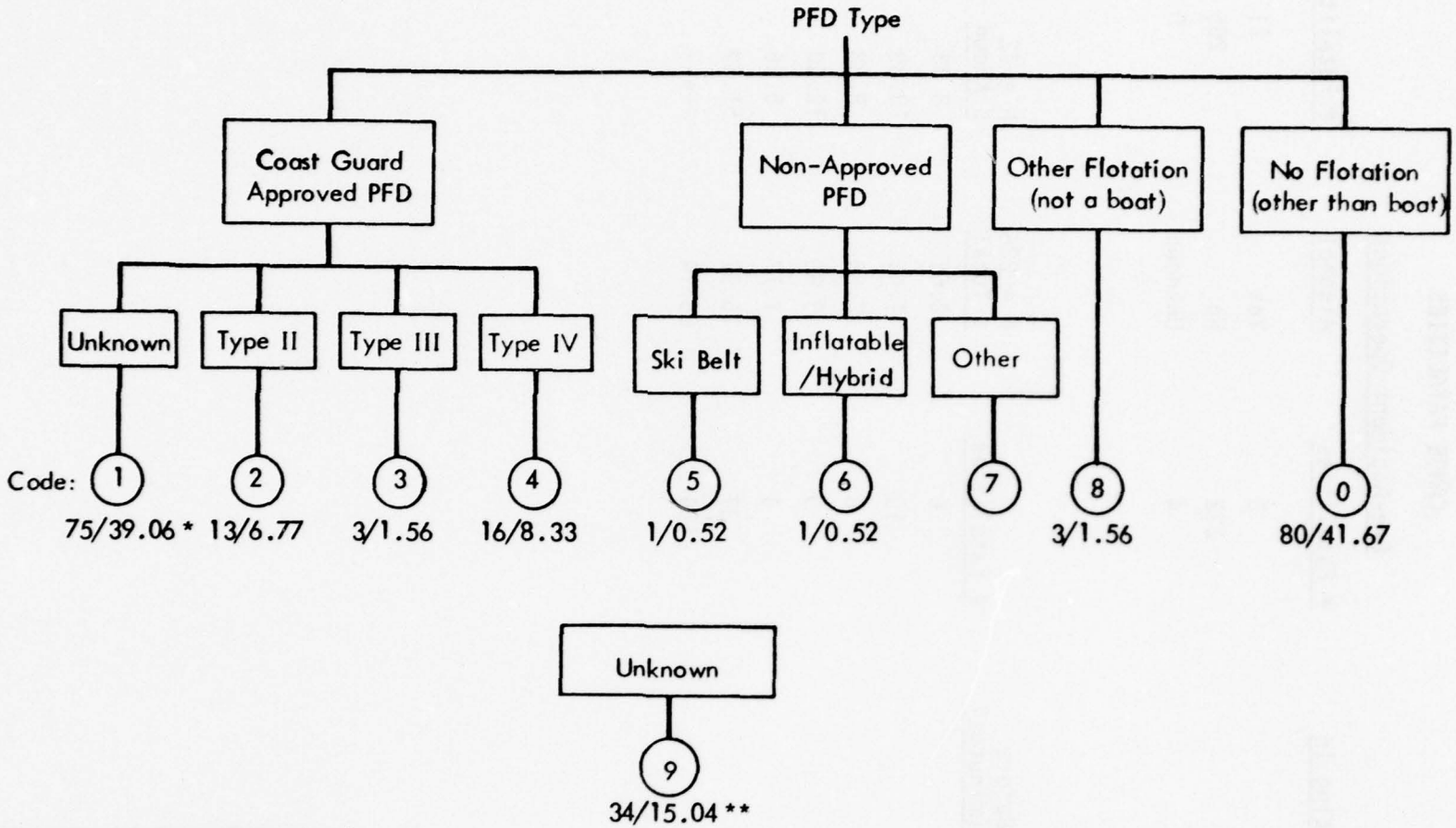
Pre-Accident Operations

Participating In Contest	# Fatalities	Alcohol	# Fatalities
Yes	0	Yes	21
No	222	No	205
Unknown	4	Unknown	0

Time Out Before Accident (minutes)	# Fatalities	N = 226 % Total	N = 72 % Known
0-1	6	2.65	8.33
2-5	10	4.42	13.89
6-10	6	2.65	8.33
11-20	9	3.98	12.50
21-30	4	1.77	5.56
31-98	37	16.37	51.39
Unknown	154	68.14	-----

CANOE FATALITIES - PRE-ACCIDENT PROFILE

TOTAL KNOWN = 192
TOTAL = 226



* NUMBER OF OCCURRENCES/
PERCENT OF TOTAL KNOWN OCCURRENCES

** NUMBER OF OCCURRENCES/PERCENT OF TOTAL OCCURRENCES

CANOE FATALITIES

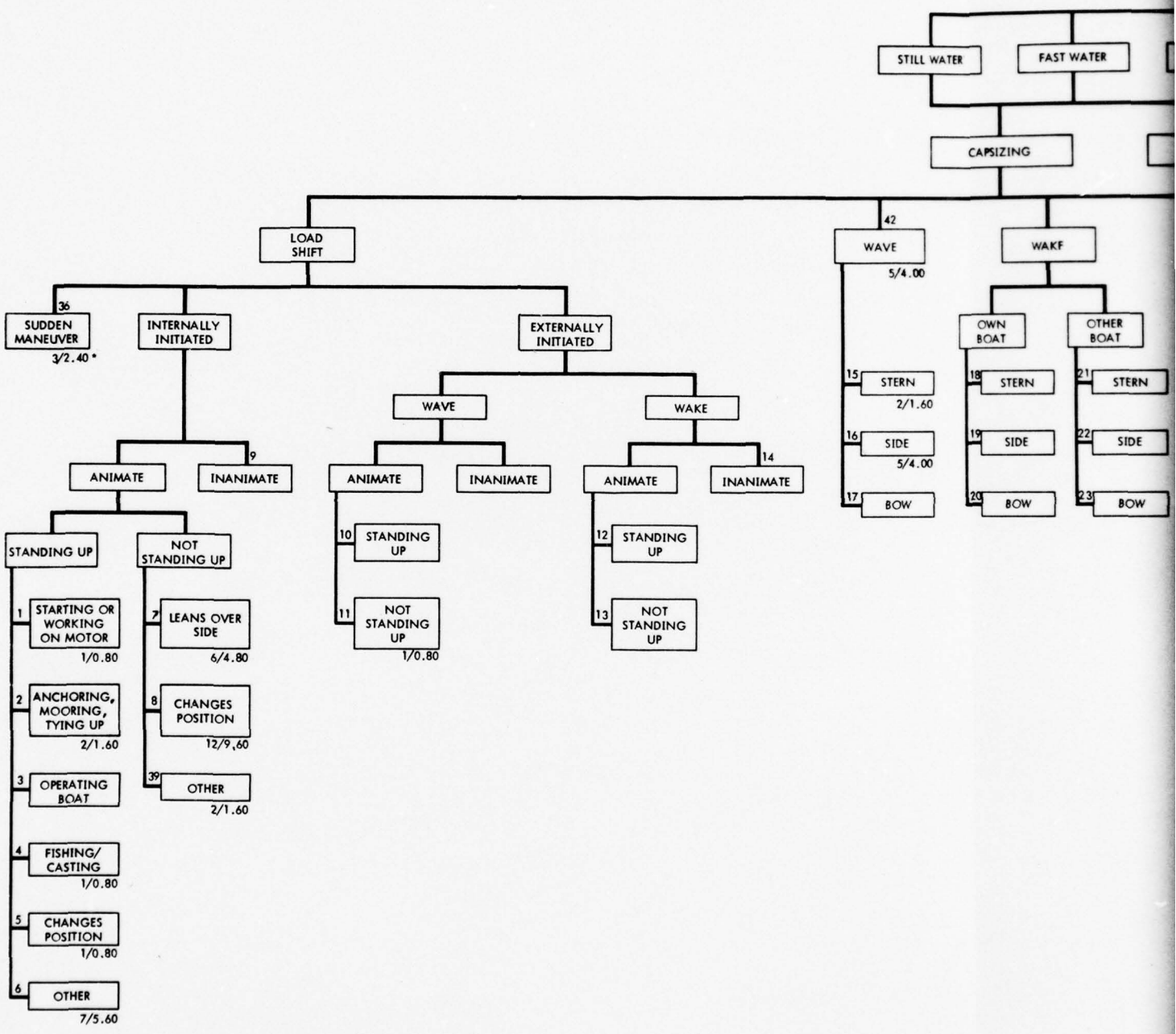
Accident Initiators Profile

Accident Type	# Fatalities
Capsizing	168
Swamping	24
Falls Overboard	15
Collision	0
Jump Overboard	1
Unknown	18

CANOE

Accide

Cause

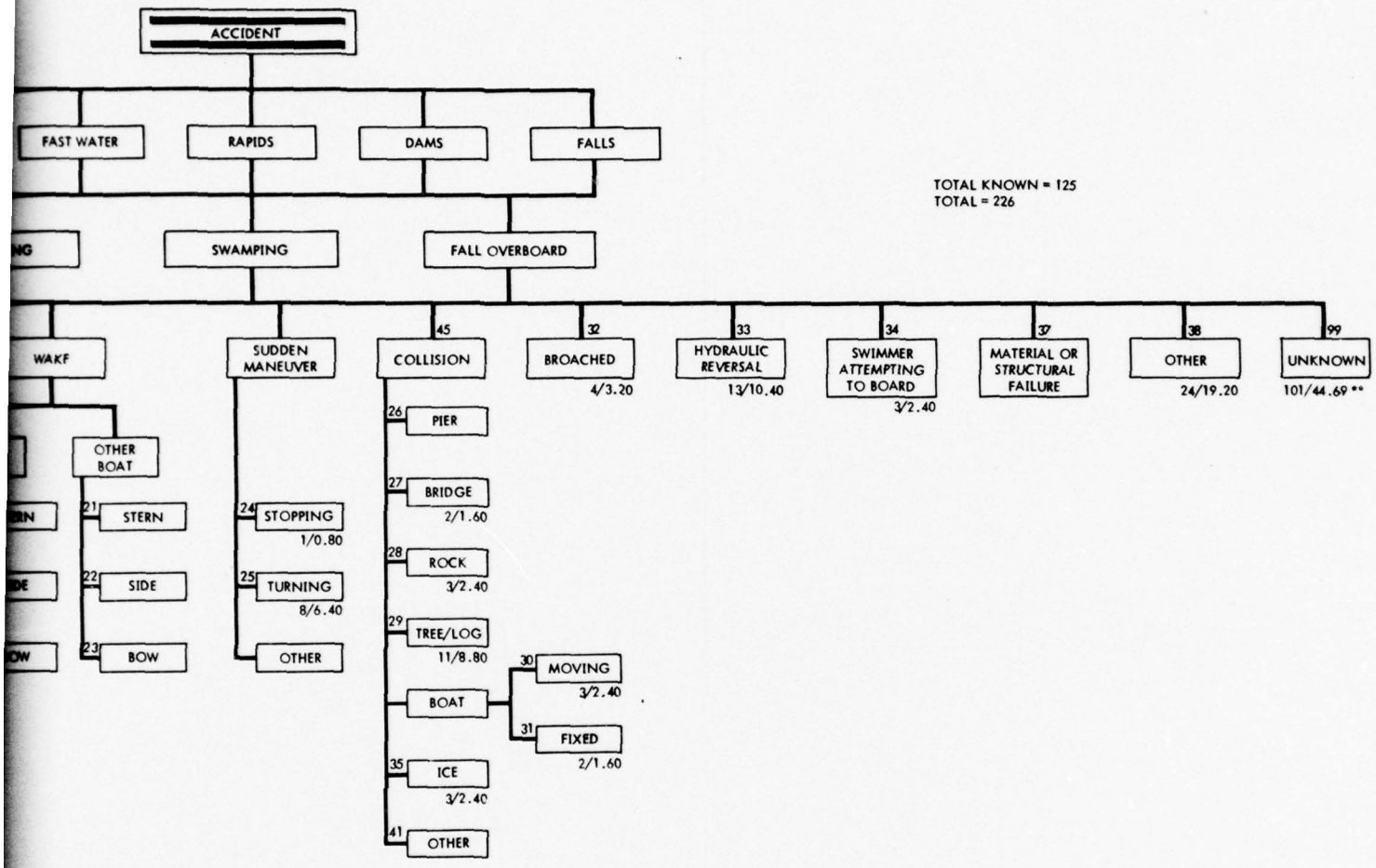


* NUMBER OF OCCURRENCES/PERCENT OF TOTAL KNOWN OCCURRENCES
** NUMBER OF OCCURRENCES/PERCENT OF TOTAL OCCURRENCES

CANOE FATALITIES

Accident Initiators

Cause of Accident



2

CANOE FATALITIES

Post Accident Operations Profile

Time Until PFD Donned/Removed (minutes)	# Fatalities	N = 226 % Total	N = 213 % Known
0-1	6	2.65	2.82
2-5	1	0.44	0.47
6-10	0	-----	-----
11-20	1	0.44	0.44
21-30	0	-----	-----
31-97	0	-----	-----
98	89	39.38	41.78
Unknown	13	5.75	-----
Not Applicable	116	51.33	54.46

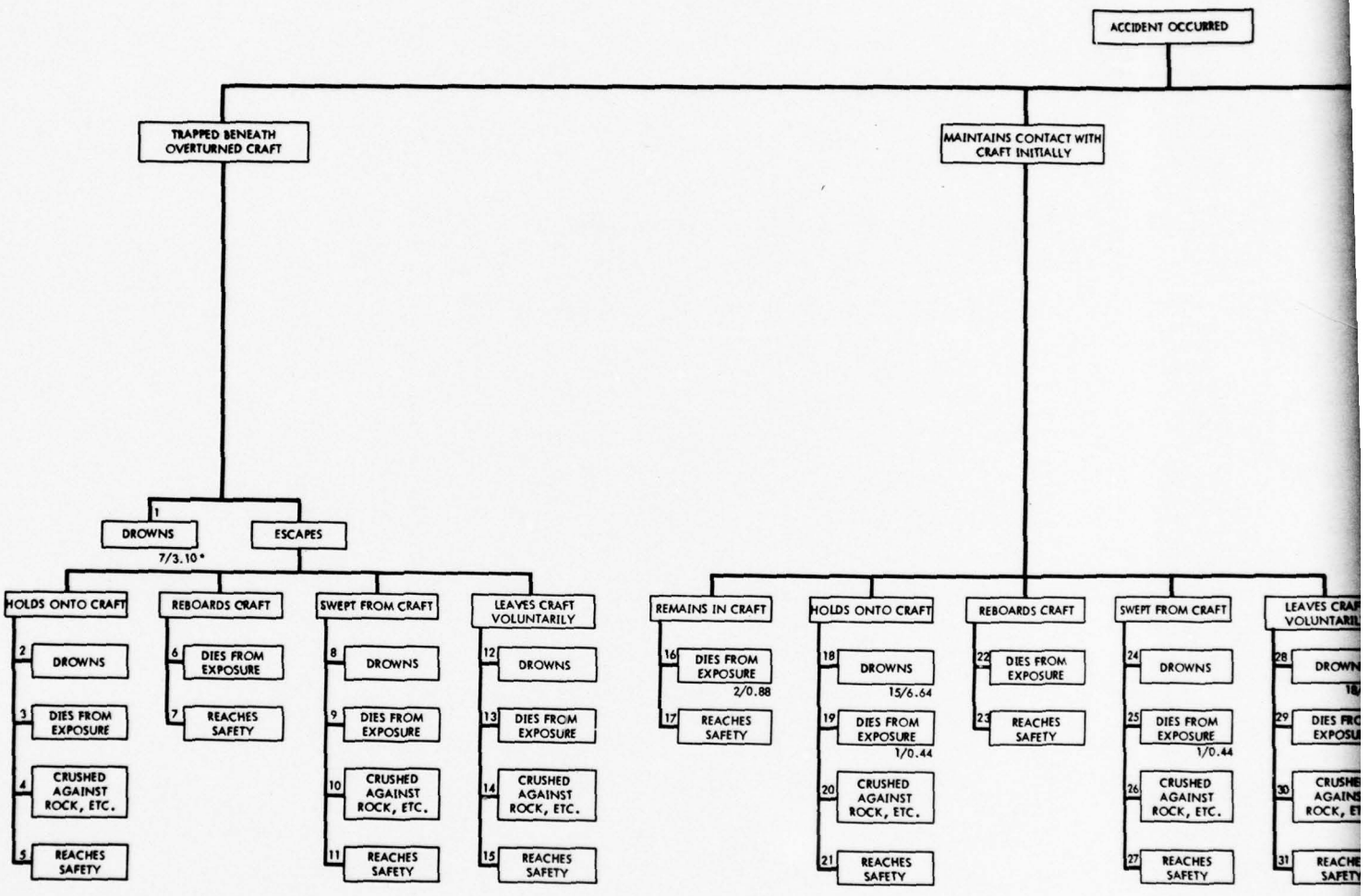
Time from Accident To Drowning (minutes)	# Fatalities	N = 226 % Total	N = 134 % Known
0-5	115	50.88	85.82
6-10	6	2.65	4.48
11-20	6	2.65	4.48
21-30	3	1.33	2.24
31-40	1	0.44	0.75
41-50	0	-----	-----
51-60	2	0.88	1.49
61-70	0	-----	-----
71-80	0	-----	-----
81-90	0	-----	-----
91-98	1	0.44	0.75
Unknown	92	40.71	

PFD Malfunction	# Fatalities	Improper PFD Use	# Fatalities
Yes	1	Yes	7
No	23	No	24
Not Applicable	164	Not Applicable	165
Unknown	38	Unknown	30

CANOE FATALITIES

Post-Accident Profile

Victim Post-Accident Situati

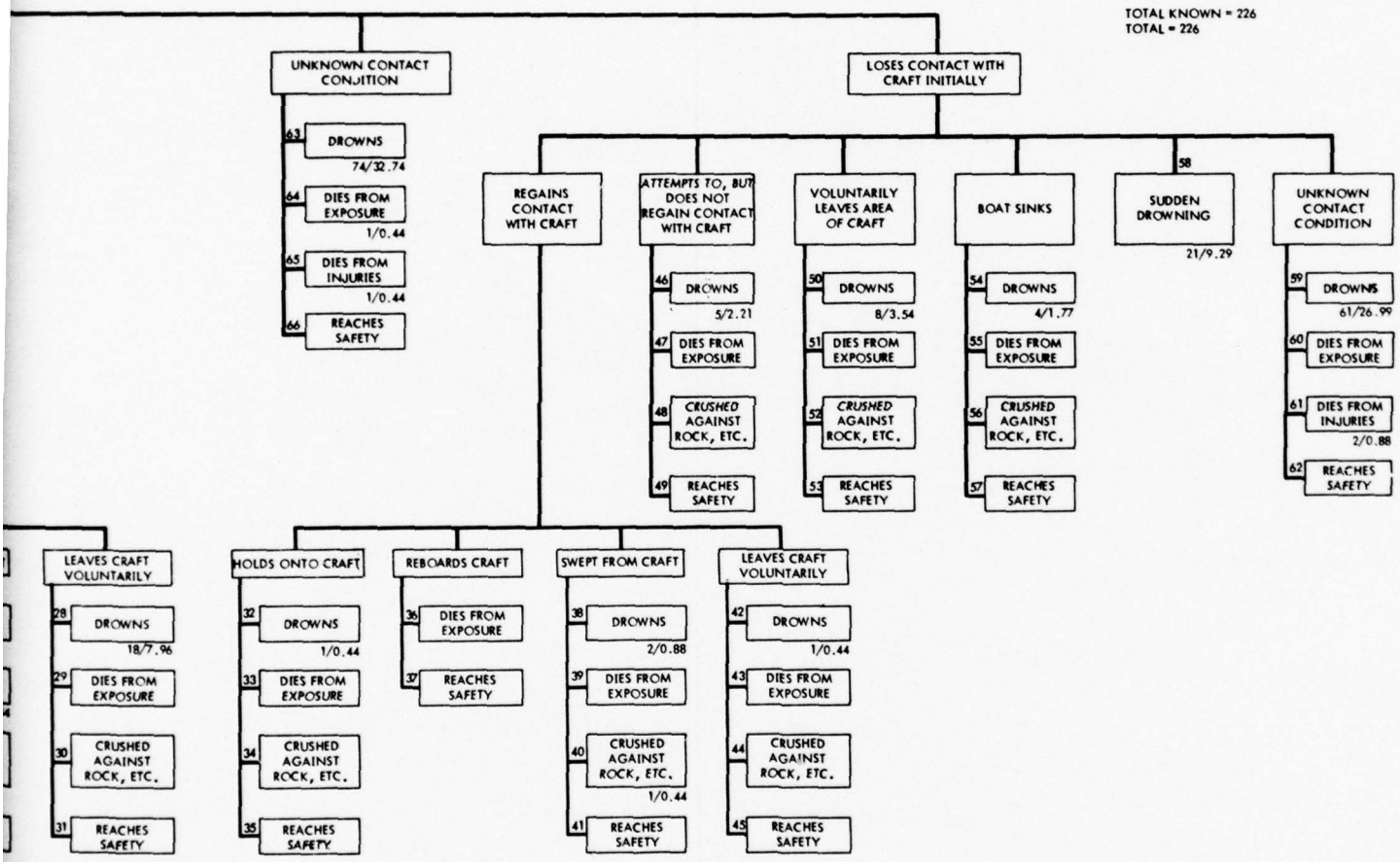


* NUMBER OF OCCURRENCES/PERCENT OF TOTAL KNOWN OCCURRENCES

ES

ofile

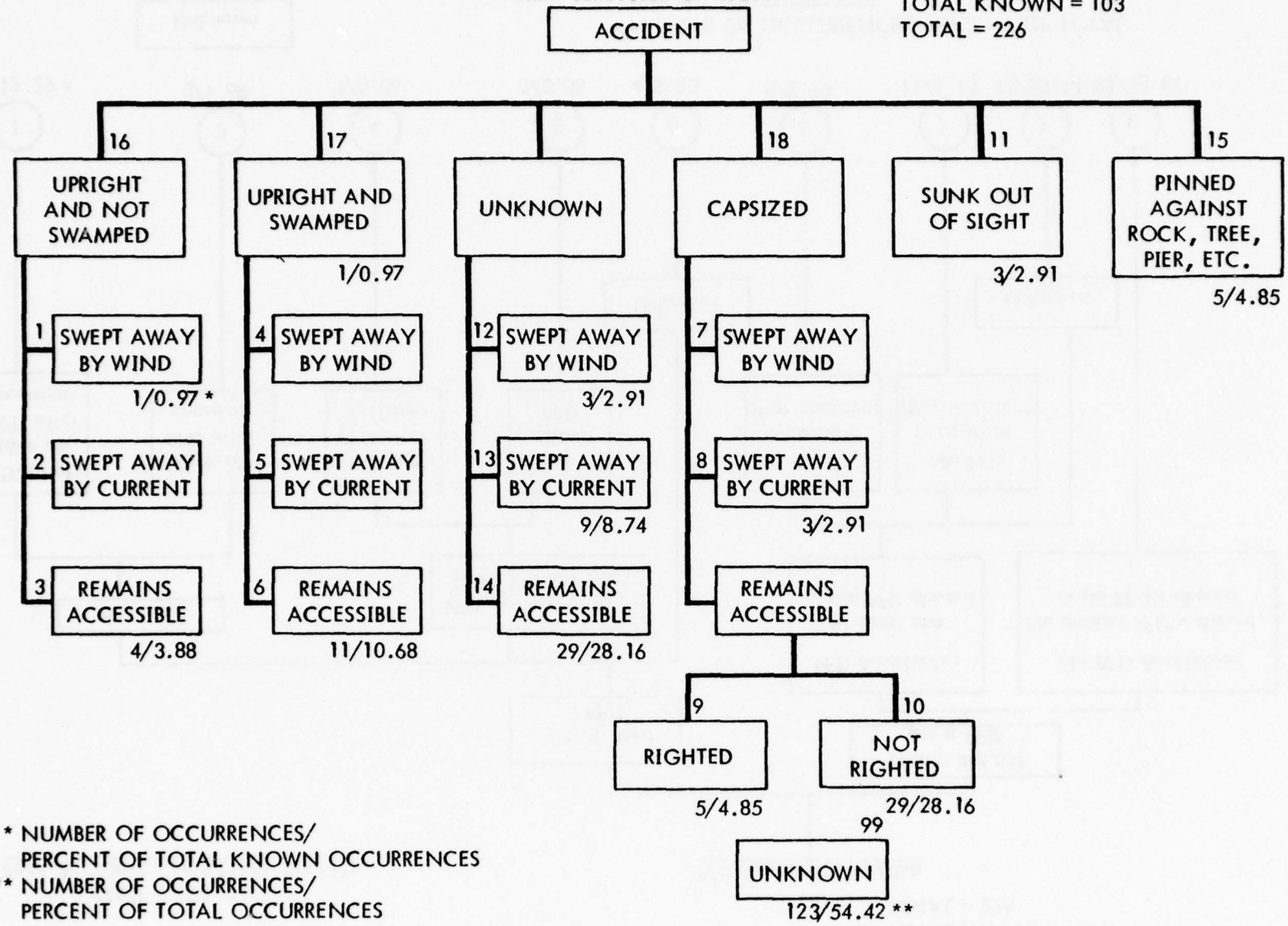
Situation



CANOE FATALITIES

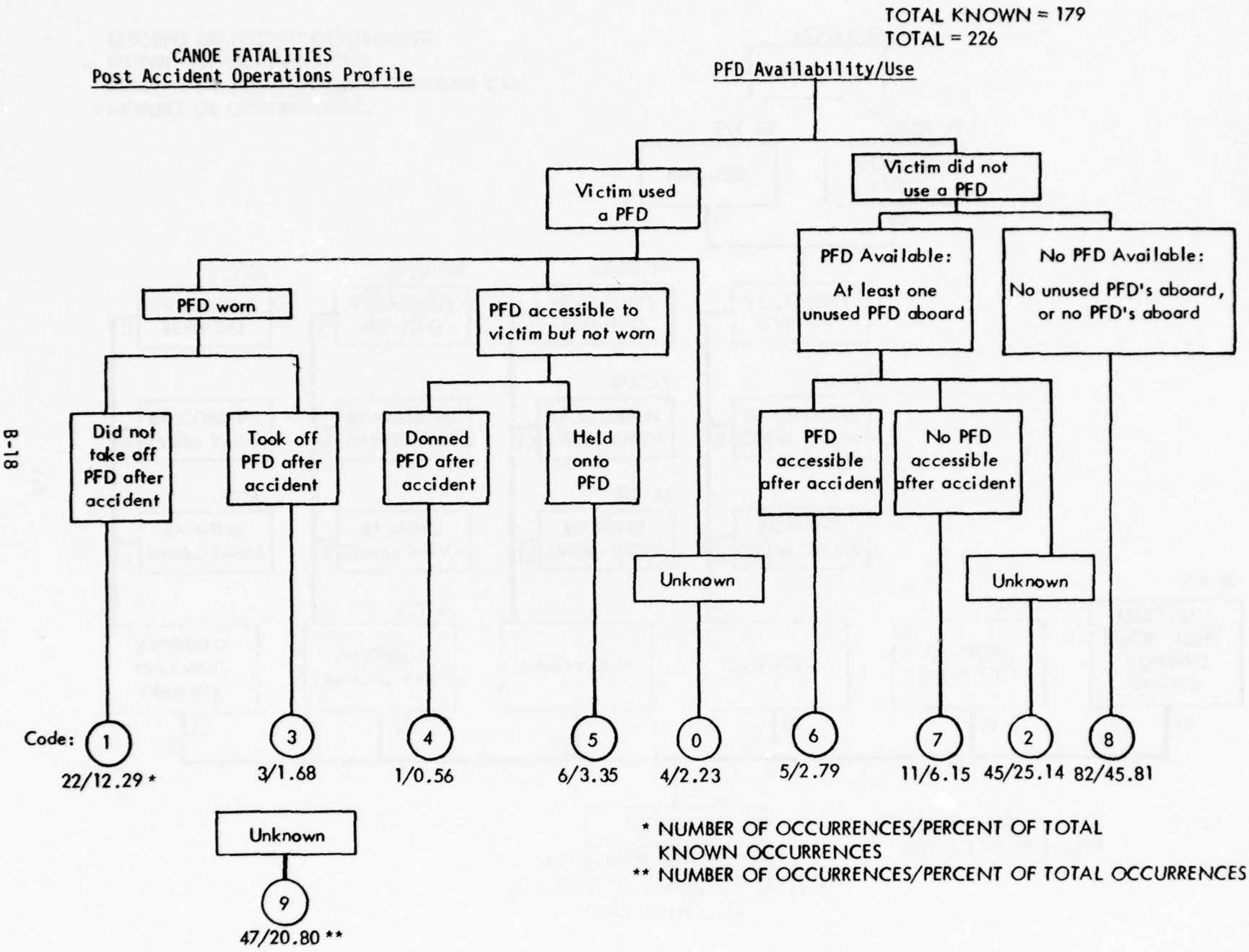
Post Accident Operations Profile

Final Condition of Craft



* NUMBER OF OCCURRENCES/
PERCENT OF TOTAL KNOWN OCCURRENCES

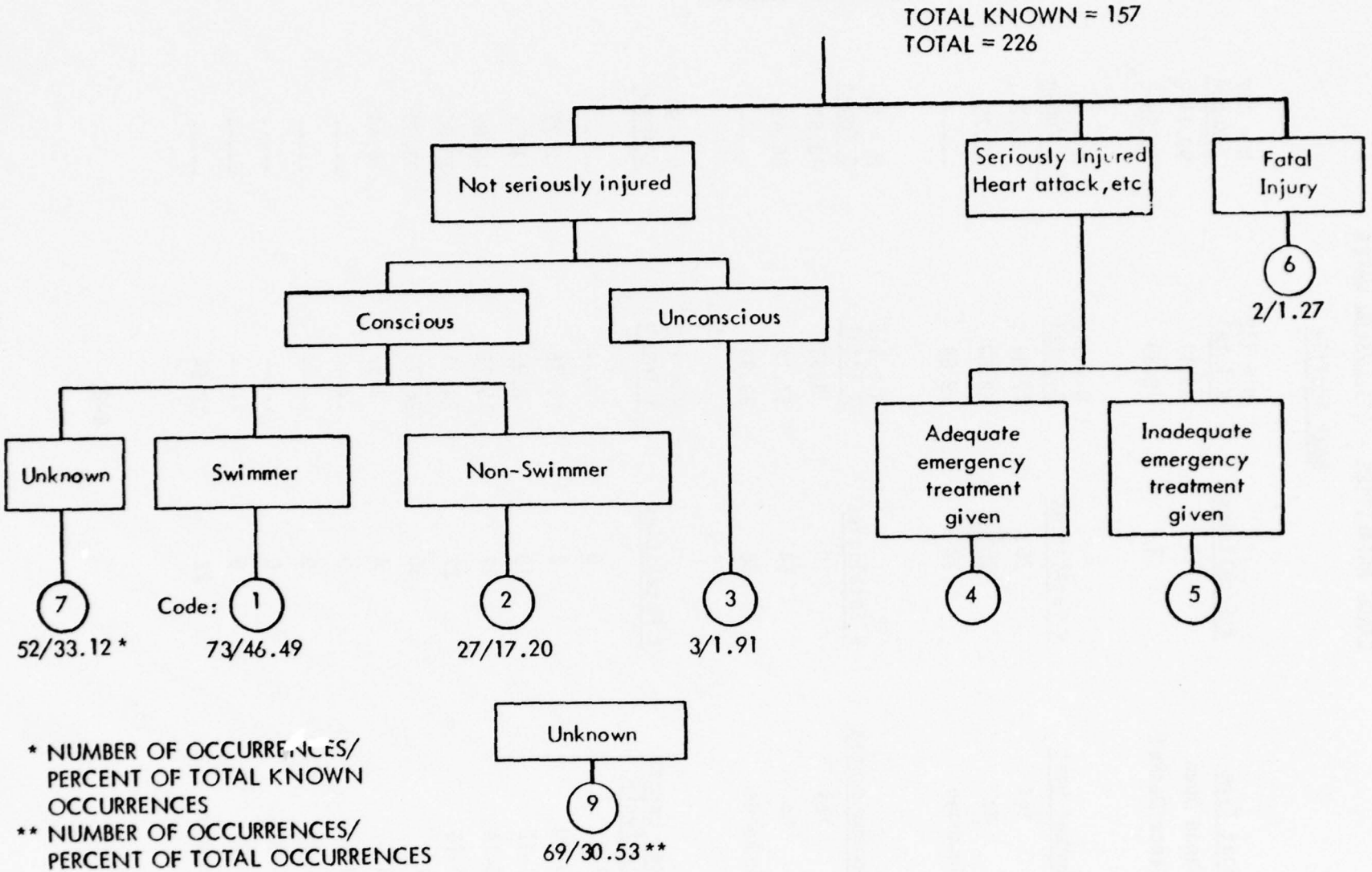
** NUMBER OF OCCURRENCES/
PERCENT OF TOTAL OCCURRENCES


TOTAL KNOWN = 179
TOTAL = 226
CANOE FATALITIES
Post Accident Operations Profile
PFD Availability/Use
Victim used a PFD
Victim did not use a PFD
PFD worn
PFD accessible to victim but not worn
PFD Available: At least one unused PFD aboard
No PFD Available: No unused PFD's aboard, or no PFD's aboard
Did not take off PFD after accident
Took off PFD after accident
Donned PFD after accident
Held onto PFD
Unknown
PFD accessible after accident
No PFD accessible after accident
Unknown
Code:
1
22/12.29 *
3
3/1.68
4
1/0.56
5
6/3.35
0
4/2.23
6
5/2.79
7
11/6.15
2
45/25.14
8
82/45.81
Unknown
9
47/20.80 **
* NUMBER OF OCCURRENCES/PERCENT OF TOTAL KNOWN OCCURRENCES
** NUMBER OF OCCURRENCES/PERCENT OF TOTAL OCCURRENCES

CANOE FATALITIES

Post Accident Profile

Victims' Condition



* NUMBER OF OCCURRENCES/ PERCENT OF TOTAL KNOWN OCCURRENCES

** NUMBER OF OCCURRENCES/ PERCENT OF TOTAL OCCURRENCES

CANOE FATALITIES - STILL/SLOW WATER

Boat Profile

Boat Type	# Fatalities	N = 112 % Total	N = 112 % Known
Canoe Open	111	99.11	99.11
Canoe Decked	1	0.89	0.89

Rented Boat	# Fatalities	N = 112 % Total	N = 90 % Known
Yes	20	17.86	22.22
No	70	62.50	77.78
Unknown	22	19.64	-----

Homemade Boat	# Fatalities	N = 112 % Total	N = 74 % Known
Yes	10	8.93	13.51
No	64	57.14	86.49
Unknown	38	33.93	-----

Boat Length (In Feet)	# Fatalities	N = 112 % Total	N = 90 % Known
1-8	0	-----	-----
9-10	2	1.79	2.22
11-12	10	8.93	11.11
13-14	17	15.18	18.89
15-16	27	24.11	30.00
17	30	26.79	33.33
18	4	3.57	4.44
19-20	0	-----	-----
21-25	0	-----	-----
26-30	0	-----	-----
31-98	0	-----	-----
Unknown	22	19.64	-----

CANOE FATALITIES - STILL/SLOW WATER

Boat Profile

Boat Material	# Fatalities	N = 112 % Total	N = 98 % Known
Wood	8	7.14	8.16
Aluminum	62	55.36	63.27
Fiberglass	25	22.32	25.51
Rubber	3	2.68	3.06
Unknown	14	12.50	-----

Boat Horsepower On Board	# Fatalities	N = 112 % Total	N = 98 % Known
0	88	78.57	89.80
1 - 10	10	8.93	10.20
11 - 20	0	-----	-----
21 - 98	0	-----	-----
Unknown	14	12.50	-----

CANOE FATALITIES - STILL/SLOW WATER

Occupants Profile

Occupants Age	# Fatalities	N = 112 % Total	N = 104 % Known
0-9	2	1.79	1.92
10-15	10	8.93	9.62
16-18	27	24.11	25.96
19-21	18	16.07	17.31
22-26	23	20.54	22.12
27-30	9	8.04	8.65
31-39	4	3.57	3.85
40-49	4	3.57	3.85
50-59	4	3.57	3.85
60-98	3	2.68	2.88
Unknown	8	7.14	-----

Occupants Sex	# Fatalities	N = 112 % Total	N = 112 % Known
Male	106	94.64	94.64
Female	6	5.36	5.36

Occupants General Boating Instruction	# Fatalities	N = 112 % Total	N = 34 % Known
Yes	2	1.79	5.88
No	32	28.57	94.12
Unknown	78	69.64	-----

Occupants Canoe Boating Instruction	# Fatalities	N = 112 % Total	N = 37 % Known
Yes	4	3.57	10.81
No	33	29.46	89.19
Unknown	75	66.96	-----

CANOE FATALITIES - STILL/SLOW WATER

Occupant Profile

Occupants Total Boating Experience	# Fatalities
Less than 20 hrs	27
20 to 100 hrs	3
100 to 500 hrs	0
Greater than 500 hrs	6
Unknown	76

Occupants Canoe Boating Experience	# Fatalities
Less than 20 hrs	26
20 to 100 hrs	4
100 to 500 hrs	3
Greater than 500 hrs	2
Unknown	77

Health	# Fatalities
Good	109
History of Heart Trouble	1
Other Poor Health	2

CANOE FATALITIES - STILL/SLOW WATER

Environment Profile

State	# Fatalities	State	# Fatalities
Ohio	12	Kentucky	2
Michigan	9	Massachusetts	2
New York	9	Mississippi	2
California	7	Missouri	2
Minnesota	7	Oregon	2
Pennsylvania	6	Alaska	1
Connecticut	5	Arkansas	1
Illinois	4	Louisiana	1
Wisconsin	4	Maine	1
Wyoming	4	Montana	1
Alabama	3	New Hampshire	1
Colorado	3	New Jersey	1
Idaho	3	New Mexico	1
Iowa	3	Oklahoma	1
Kansas	3	Rhode Island	1
North Carolina	3	Utah	1
Virginia	3	South Carolina	1
Indiana	2		

Month	# Fatalities	Month	# Fatalities
January	4	July	13
February	1	August	17
March	6	September	7
April	12	October	5
May	22	November	5
June	17	December	3

CANOE FATALITIES - STILL/SLOW WATER

Environment Profile

Body Of Water	# Fatalities
River, Creek	23
Lake, Pond	80
Great Lakes	4
Coastal Bay, Inlet, Etc.	4
Ocean	0
Unknown	1

Distance From Shore	# Fatalities
50 ft	19
51 ft to 100 ft	9
101 ft to 250 ft	10
251 ft to 500 ft	15
501 ft to 4900 ft	11
Unknown	48

Water Conditions	# Fatalities
Calm	66
Choppy	13
Rough	22
Rapids, Falls, Dams	0
Unknown	11

Air Temperature	# Fatalities
1° to 10°	0
11° to 20°	0
21° to 30°	0
31° to 40°	7
41° to 50°	8
51° to 60°	3
61° to 70°	8
71° to 80°	11
81° to 94°	8
Very Cold	1
Cold	3
Warm	11
Very Warm	2
Unknown	50

Type Of Water	# Fatalities
Still	19
Slow	40
Fast	10
Rapids	20
Falls	3
Dam	20
Unknown	0

Wind	# Fatalities
None	19
Light (0-6 mph)	40
Moderate (7-14 mph)	10
Strong (15-25 mph)	20
Storm (over 25 mph)	3
Unknown	20

Water Temperature	# Fatalities
1° to 30°	0
31° to 40°	15
41° to 50°	7
51° to 60°	6
61° to 70°	8
71° to 80°	6
81° to 95°	2
Not Relevant	19
Cold	19
Very Cold	3
Unknown	27

CANOE FATALITIES - STILL/SLOW WATER

Pre-Accident Operations Profile

Persons On Board	# Fatalities
1	24
2	47
3	23
4	13
5	4
6	0
7	0
8	0
9	1
Unknown	0

PFDs On Board	# Fatalities
0	42
1	11
2	29
3	11
4	6
5	0
6	0
7	0
8	0
9	0
10 - 98	0
Unknown	13

Participating In Contest	# Fatalities
Yes	0
No	112
Unknown	0

Alcohol	# Fatalities
Yes	12
No	100
Unknown	0

PFD Type	# Fatalities
Coast Guard Approved	
Unknown	35
Type II	6
Type III	0
Type IV	7
Not Approved	
Ski-Belt	0
Inflatable/Hybrid	1
Other	0
Other Flotation (not a boat)	1
No Flotation (other than boat)	49
Unknown	13

Contributing Factors	# Fatalities
Flood Swollen Waters	8
Horseplay (excessive and unnecessary)	4
Unfamiliar Waters	0
Over-Confidence	3
Other	6
None	12
Unknown	5
Not Coded	74

CANOE FATALITIES - STILL/SLOW WATER

Accident Initiators Profile

Accident Type	# Fatalities
Capsizing	75
Swamping	11
Fall Overboard	13
Collision	0
Jump Overboard	1
Unknown	12

INFLATABLE FATALITIES

Boat Profile

Boat Type	# Fatalities	N = 86 % Total	N = 86 % Known
Inflatable Canoe	0	-----	-----
Inflatable Raft	86	100.00	100.00

Rented Boat	# Fatalities	N = 86 % Total	N = 67 % Known
Yes	1	1.16	1.49
No	66	76.74	98.51
Unknown	19	22.09	-----

Homemade Boat	# Fatalities	N = 86 % Total	N = 85 % Known
Yes	0	-----	-----
No	85	98.84	100.00
Unknown	1	1.16	-----

Boat Length (ft)	# Fatalities	N = 86 % Total	N = 38 % Known
1 to 8	12	13.95	31.58
9 to 10	9	10.47	23.68
11 to 12	3	3.49	7.89
13 to 14	0	-----	-----
15 to 16	0	-----	-----
17	1	1.16	2.63
18	0	-----	-----
19 to 20	12	13.95	31.58
21 to 25	0	-----	-----
26 to 30	1	1.16	2.63
31 to 98	0	-----	-----
Unknown	48	55.81	-----

Horsepower On Board	# Fatalities	N = 86 % Total	N = 75 % Known
0	73	84.88	97.33
1 to 10	1	1.16	1.33
11 to 20	0	-----	-----
21 to 98	1	1.16	1.33
Unknown	11	12.79	-----

INFLATABLE FATALITIES

Occupant Profile

Occupants Health	# Fatalities	N = 86 % Total	N = 86 % Known
Good	82	95.35	95.35
History of Heart Trouble	1	1.16	1.16
Other Poor Health	3	3.49	3.49

Occupants Age - Years	# Fatalities	N = 86 % Total	N = 82 % Known
0 - 9	3	3.49	3.66
10 - 15	8	9.30	9.76
16 - 18	13	15.12	15.85
19 - 21	19	22.09	23.17
22 - 26	20	23.26	24.39
27 - 30	10	11.63	12.20
31 - 39	5	5.81	6.10
40 - 49	2	2.33	2.44
50 - 59	1	1.16	1.22
60 - 98	1	1.16	1.22
Unknown	4	4.65	-----

INFLATABLE FATALITIES

Occupant Profile

Occupants Sex	# Fatalities	N = 86 % Total	N = 85 % Known
Male	79	91.06	92.94
Female	6	6.98	7.06
Unknown	1	1.16	-----

Formal Boating Instruction - General	# Fatalities	N = 86 % Total	N = 23 % Known
Yes	1	1.16	4.35
No	22	25.58	95.65
Unknown	63	73.26	-----

Occupants Boating Experience - Total	# Fatalities	N = 86 % Total	N = 13 % Known
Less than 20 hrs	7	8.14	53.85
20 to 100 hrs	3	3.49	23.08
100 to 500 hrs	1	1.16	7.69
Greater than 500 hrs	2	2.33	15.38
Unknown	73	84.88	-----

Occupants Boating Experience - Inflatable	# Fatalities	N = 86 % Total	N = 13 % Known
Less than 20 hrs	7	8.14	53.85
20 to 100 hrs	3	3.49	23.08
100 to 500 hrs	1	1.16	7.69
Greater than 500 hrs	2	2.33	15.38
Unknown	73	84.88	-----

INFLATABLE FATALITIES

Environment Profile

State	# Fatalities	N = 86 % Total	N = 86 % Known
California	24	27.91	27.91
Ohio	6	6.98	6.98
Pennsylvania	6	6.98	6.98
Oregon	5	5.81	5.81
Michigan	4	4.65	4.65
Montana	4	4.65	4.65
Wisconsin	4	4.65	4.65
Connecticut	3	3.49	3.49
Massachusetts	3	3.49	3.49
Alaska	2	2.33	2.33
Colorado	2	2.33	2.33
Florida	2	2.33	2.33
Iowa	2	2.33	2.33
New York	2	2.33	2.33
North Carolina	2	2.33	2.33
South Carolina	2	2.33	2.33
Tennessee	2	2.33	2.33
Utah	2	2.33	2.33
Alabama	1	1.16	1.16
Arizona	1	1.16	1.16
Kansas	1	1.16	1.16
Kentucky	1	1.16	1.16
Maryland	1	1.16	1.16
Minnesota	1	1.16	1.16
Washington	1	1.16	1.16
West Virginia	1	1.16	1.16
Wyoming	1	1.16	1.16

INFLATABLE FATALITIES

Environment Profile

Month	# Fatalities	N = 86 % Total	Month	# Fatalities	N = 86 % Total
January	1	1.16	July	13	15.12
February	7	8.14	August	4	4.65
March	7	8.14	September	1	1.16
April	11	12.79	October	0	-----
May	20	23.26	November	1	1.16
June	21	24.42	December	0	-----

Time of Day	# Fatalities	N = 86 % Total	N = 70 % Known	Time of Day	# Fatalities	N = 86 % Total	N = 70 % Known
2400	0	-----	-----	1200	3	3.49	4.29
0100	0	-----	-----	1300	2	2.33	2.86
0200	0	-----	-----	1400	14	16.28	20.00
0300	0	-----	-----	1500	4	4.65	5.71
0400	0	-----	-----	1600	12	13.95	17.14
0500	0	-----	-----	1700	10	11.63	14.29
0600	0	-----	-----	1800	5	5.81	7.14
0700	0	-----	-----	1900	4	4.65	5.71
0800	1	1.16	1.43	2000	4	4.65	5.71
0900	1	1.16	1.43	2100	0	-----	-----
1000	2	2.33	2.86	2200	0	-----	-----
1100	6	6.98	8.57	2300	1	1.16	1.43

	# Fatalities	N = 86 % Total	N = 70 % Known
Midnight to Sunrise	0	-----	-----
Sunrise to Noon	0	-----	-----
Noon to Sunset	1	1.16	1.43
Sunset to Midnight	0	-----	-----
Unknown	16	18.60	-----

INFLATABLE FATALITIES

Environment Profile

Body of Water	# Fatalities	N = 86 % Total	N = 86 % Known
River, Creek	70	81.40	81.40
Lake, Pond	8	9.30	9.30
Great Lakes	0	-----	-----
Coastal Waters	6	6.98	6.98
Ocean	2	2.33	2.33

Type of Water	# Fatalities	N = 86 % Total	N = 86 % Known
Still	9	10.47	10.47
Slow	4	4.65	4.65
Fast	34	39.53	39.53
Rapids	20	23.26	23.26
Falls	3	3.49	3.49
Dam	16	18.60	18.60

Distance From Shore	# Fatalities	N = 86 % Total	N = 40 % Known
50 ft	24	27.91	60.00
51 to 100 ft	9	10.47	22.50
101 to 250 ft	5	5.81	12.50
251 to 500 ft	1	1.16	2.50
501 to 4900 ft	1	1.16	2.50
Unknown	46	53.49	-----

Wind Conditions	# Fatalities	N = 86 % Total	N = 55 % Known
None	13	15.12	23.64
Light (0-6 mph)	25	29.07	45.45
Moderate (7-14 mph)	11	12.79	20.00
Strong (15-25 mph)	5	5.81	9.09
Storm (over 25 mph)	1	1.16	1.82
Unknown	31	36.05	-----

Water Conditions	# Fatalities	N = 86 % Total	N = 72 % Known
Calm	8	9.30	11.11
Choppy	6	6.98	8.33
Rough	15	17.44	20.83
Rapids, Falls, Dam	43	50.00	59.72
Unknown	14	16.28	-----

INFLATABLE FATALITIES

Environment Profile

Water Temperature	# Fatalities	N = 86 % Total	N = 46 % Known
1° to 30°	1	1.16	2.17
31° to 40°	6	6.98	13.04
41° to 50°	6	6.98	13.04
51° to 60°	2	2.33	4.35
61° to 70°	2	2.33	4.35
71° to 80°	3	3.49	6.52
81° to 95°	0	-----	-----
Not Relevant	5	5.81	10.87
Cold	18	20.93	39.13
Very Cold	3	3.49	6.52
Unknown	40	46.51	-----

Air Temperature	# Fatalities	N = 86 % Total	N = 41 % Known
1° to 10°	0	-----	-----
11° to 20°	0	-----	-----
21° to 30°	2	2.33	4.88
31° to 40°	2	2.33	4.88
41° to 50°	5	5.81	12.20
51° to 60°	3	3.49	7.32
61° to 70°	5	5.81	12.20
71° to 80°	6	6.98	14.63
81° to 94°	3	3.49	7.32
Very Cold	0	-----	-----
Cold	1	1.16	2.44
Warm	13	15.12	31.71
Very Warm	1	1.16	2.44
Unknown	45	52.33	-----

INFLATABLE FATALITIES

Pre-Accident Operations Profile

Persons On Board	# Fatalities	N = 86 % Total	N = 86 % Known
1	13	15.12	15.12
2	46	53.49	53.49
3	13	15.12	15.12
4	4	4.65	4.65
5	4	4.65	4.65
6	6	6.98	6.98
7	0	-----	-----
8	0	-----	-----
9	0	-----	-----
Unknown	0	-----	-----

Participating In Contest	# Fatalities	N = 86 % Total
Yes	0	-----
No	86	100.00

PFDs On Board	# Fatalities	N = 86 % Total	N = 63 % Known
0	37	43.02	58.73
1	2	2.33	3.17
2	15	17.44	23.81
3	2	2.33	3.17
4	1	1.16	1.59
5	0	-----	-----
6	6	6.98	9.52
7	0	-----	-----
8	0	-----	-----
9	0	-----	-----
10-98	0	-----	-----
Unknown	23	26.74	-----

Alcohol	# Fatalities	N = 86 % Total	N = 86 % Known
Yes	3	3.49	3.49
No	83	96.51	96.51

INFLATABLE FATALITIES

Pre-Accident Operations Profile

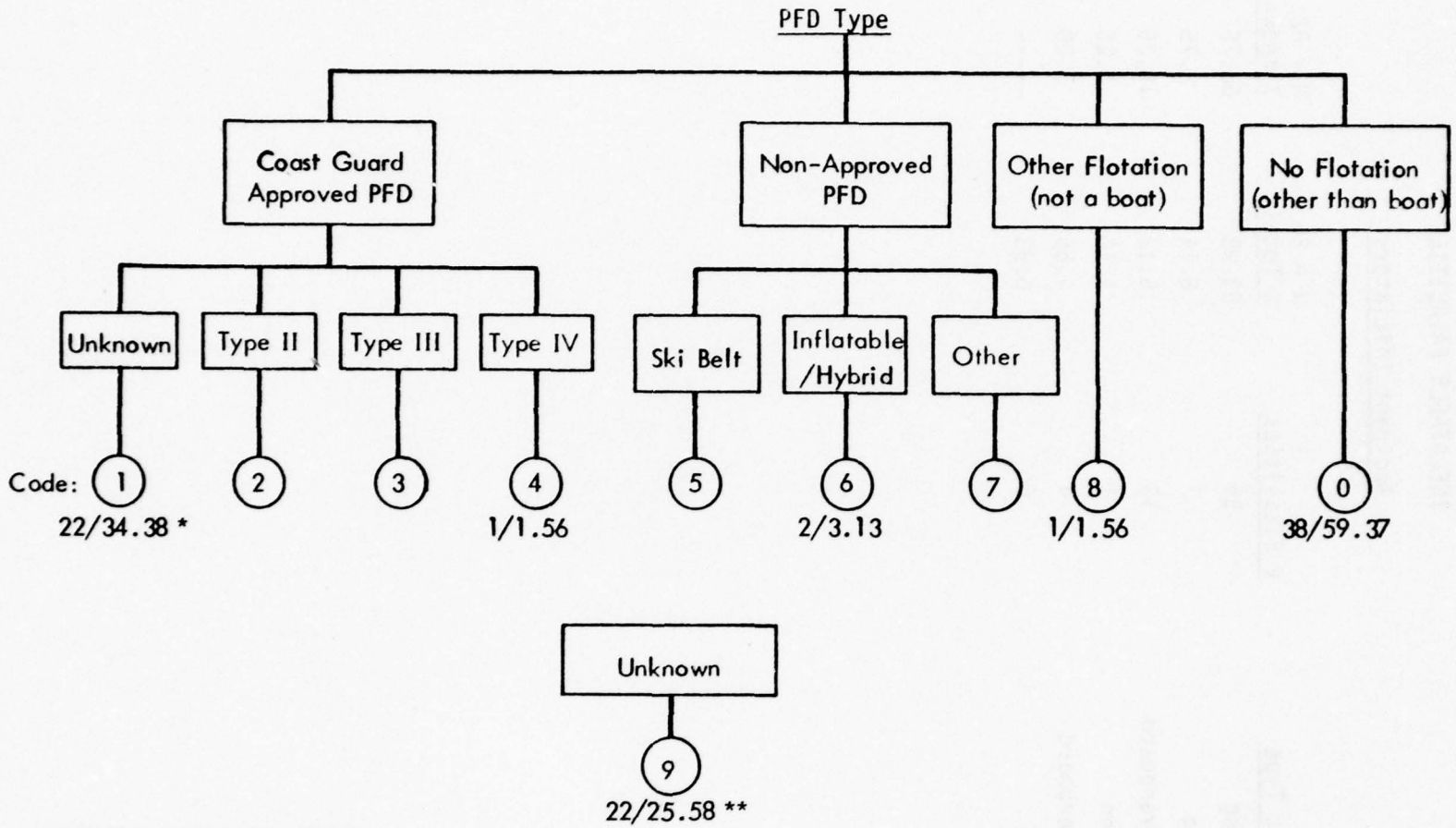
Time Out Before Accident	# Fatalities	N = 86 % Total	N = 31 % Known
0-1 min.	3	3.49	9.68
2-5 min.	4	4.65	12.90
6-10 min.	4	4.65	12.90
11-20 min.	3	3.49	9.68
21-30 min.	2	2.33	6.45
31-98 min.	15	17.44	48.39
Unknown	55	63.95	-----

Contributing Factors	# Fatalities	N = 86 % Total	N = 39 % Known
Flood Swollen Waters	12	13.95	30.77
Horseplay (excessive and unnecessary)	0	-----	-----
Unfamiliar Waters	6	6.98	15.38
Over-Confidence	3	3.49	7.69
Other	15	17.44	38.46
None	3	3.49	7.69
Unknown	5	5.81	-----
Not Coded	42	48.84	-----

INFLATABLE FATALITIES

Pre-Accident Operations Profile

TOTAL KNOWN = 64
TOTAL = 86



* NUMBER OF OCCURRENCES/
PERCENT OF TOTAL KNOWN OCCURRENCES

** NUMBER OF OCCURRENCES/PERCENT OF TOTAL OCCURRENCES

INFLATABLE FATALITIES

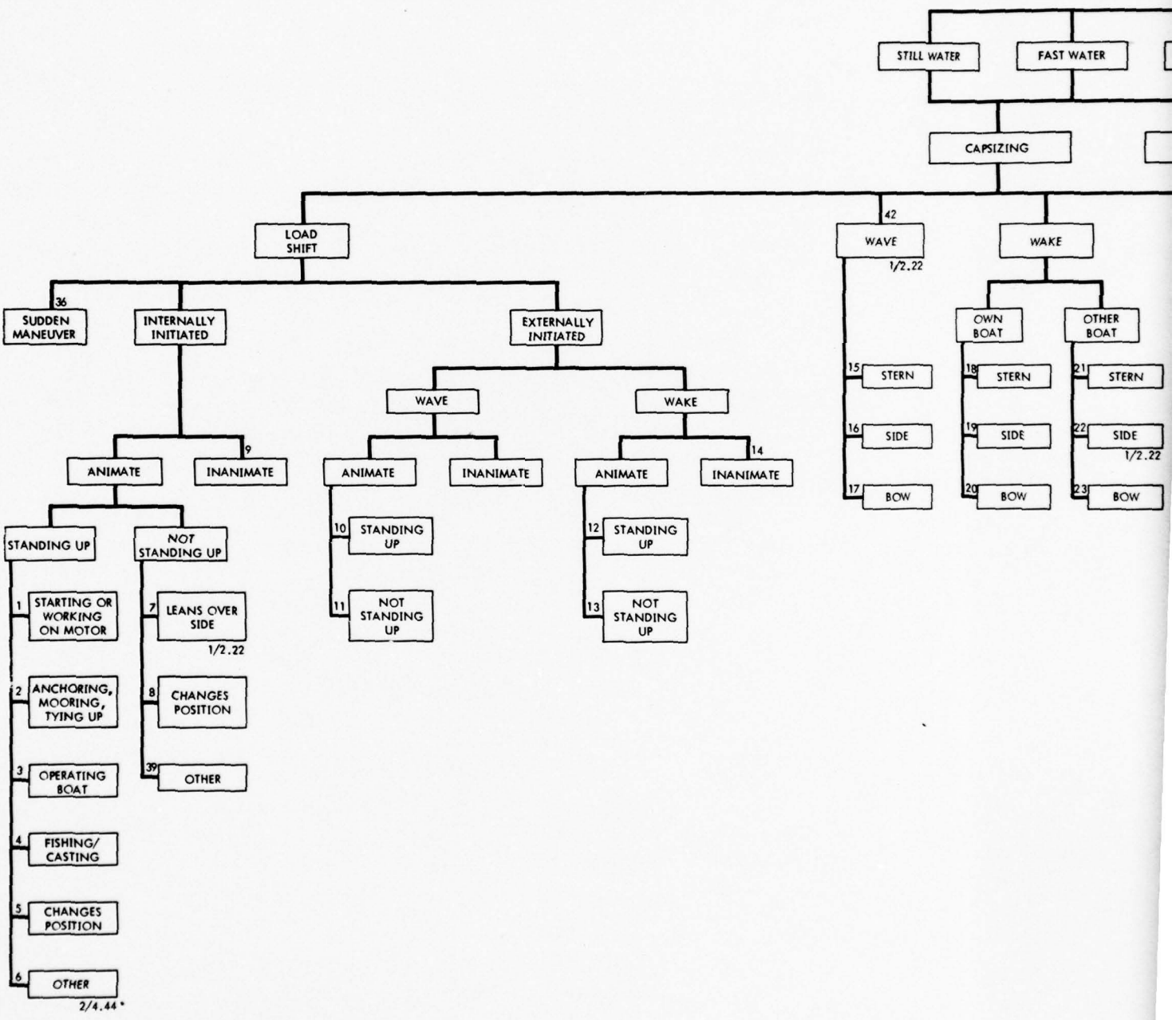
Accident Initiators

Accident Type	# Fatalities	N = 86 % Total	N = 80 % Known
Capsizing	55	63.95	68.75
Swamping	7	8.14	8.75
Falls Overboard	13	15.12	16.25
Collision	1	1.16	1.25
Jump Overboard	4	4.65	5.00
Unknown	6	6.98	-----

INFLATA

Accident I

Cause

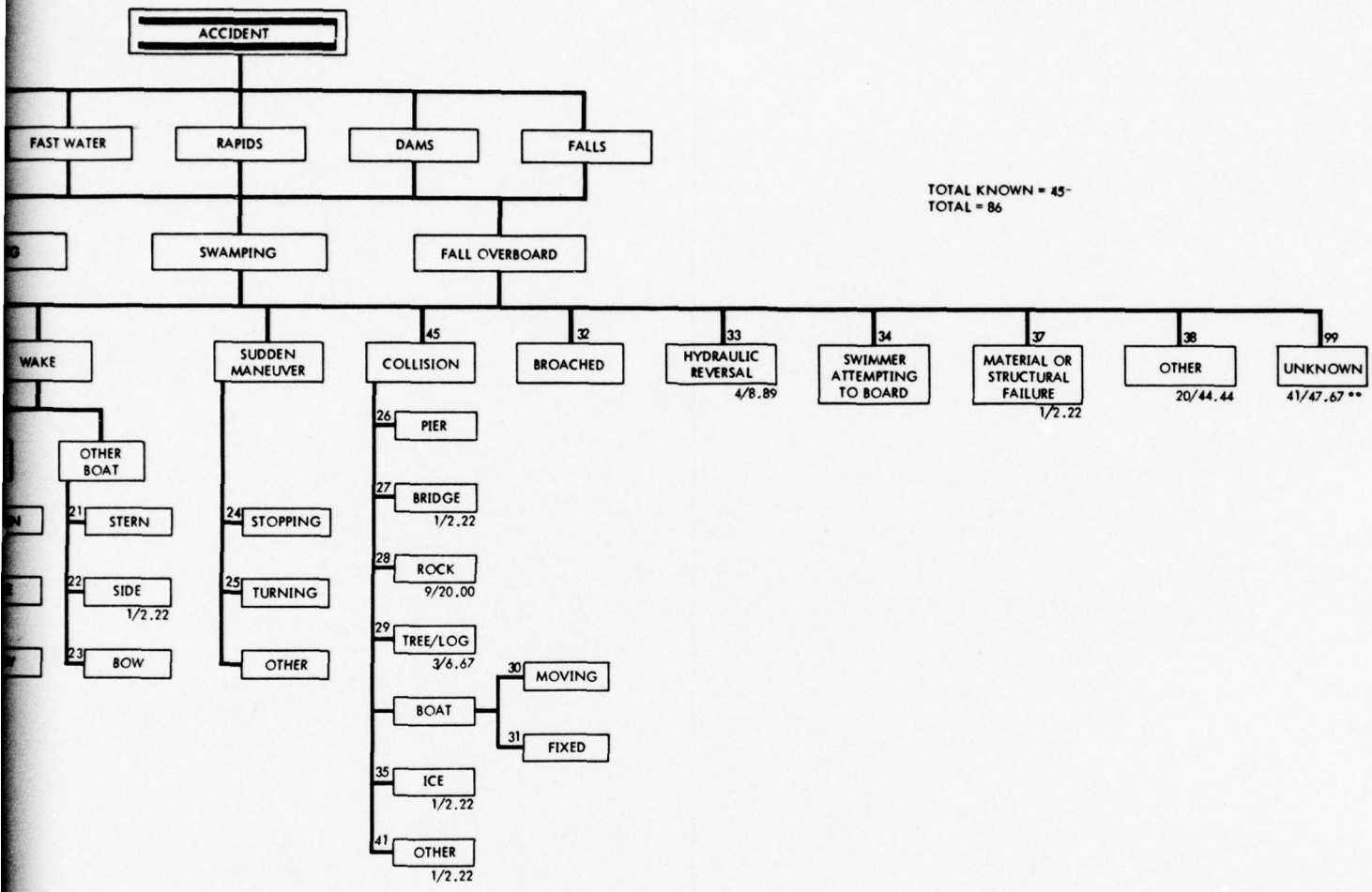


* NUMBER OF OCCURRENCES/PERCENT OF TOTAL KNOWN OCCURRENCES
** NUMBER OF OCCURRENCES/PERCENT OF TOTAL OCCURRENCES

INFLATABLE FATALITIES

Accident Initiators Profile

Cause of Accident



2

INFLATABLE FATALITIES

Post Accident Operations Profile

Time Until PFD Donned/Removed	# Fatalities	N = 86 % Total	N = 85 % Known
0-1 min.	1	1.16	1.18
2-5 min.	1	1.16	1.18
6-10 min.	0	-----	-----
11-20 min.	0	-----	-----
21-30 min.	0	-----	-----
31-97 min.	0	-----	-----
98	42	48.84	49.41
Unknown	1	1.16	-----
Not Applicable	41	47.67	48.24

Time From Accident To Drowning	# Fatalities	N = 86 % Total	N = 39 % Known
0-5 min.	38	44.19	97.44
6-10 min.	1	1.16	2.56
11-20 min.	0	-----	-----
21-30 min.	0	-----	-----
31-40 min.	0	-----	-----
41-50 min.	0	-----	-----
51-60 min.	0	-----	-----
61-70 min.	0	-----	-----
71-80 min.	0	-----	-----
81-90 min.	0	-----	-----
90-98 min.	0	-----	-----
Unknown	47	54.65	-----

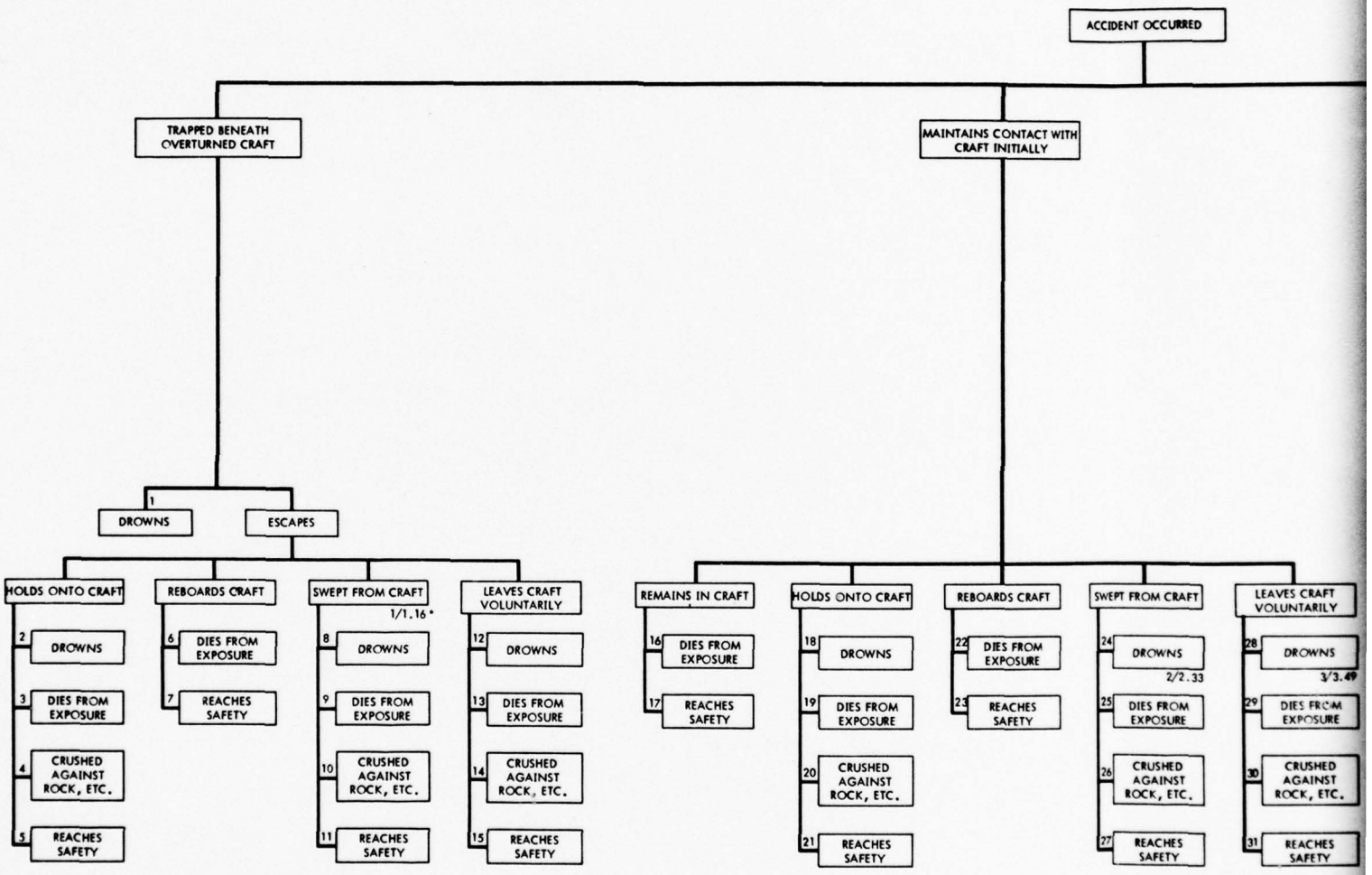
PFD Malfunction	# Fatalities	N = 86 % Total	N = 70 % Known
Yes	3	3.49	4.29
No	2	2.33	2.85
Not Applicable	65	75.58	92.86
Unknown	16	18.60	-----

Improper PFD Use	# Fatalities	N = 86 % Total	N = 75 % Known
Yes	3	3.49	4.00
No	5	5.81	6.67
Not Applicable	67	77.91	89.33
Unknown	11	12.79	-----

INFLATABLE FATALITIES

Post-Accident Operations Profile

Victims' Post-Accident Situation

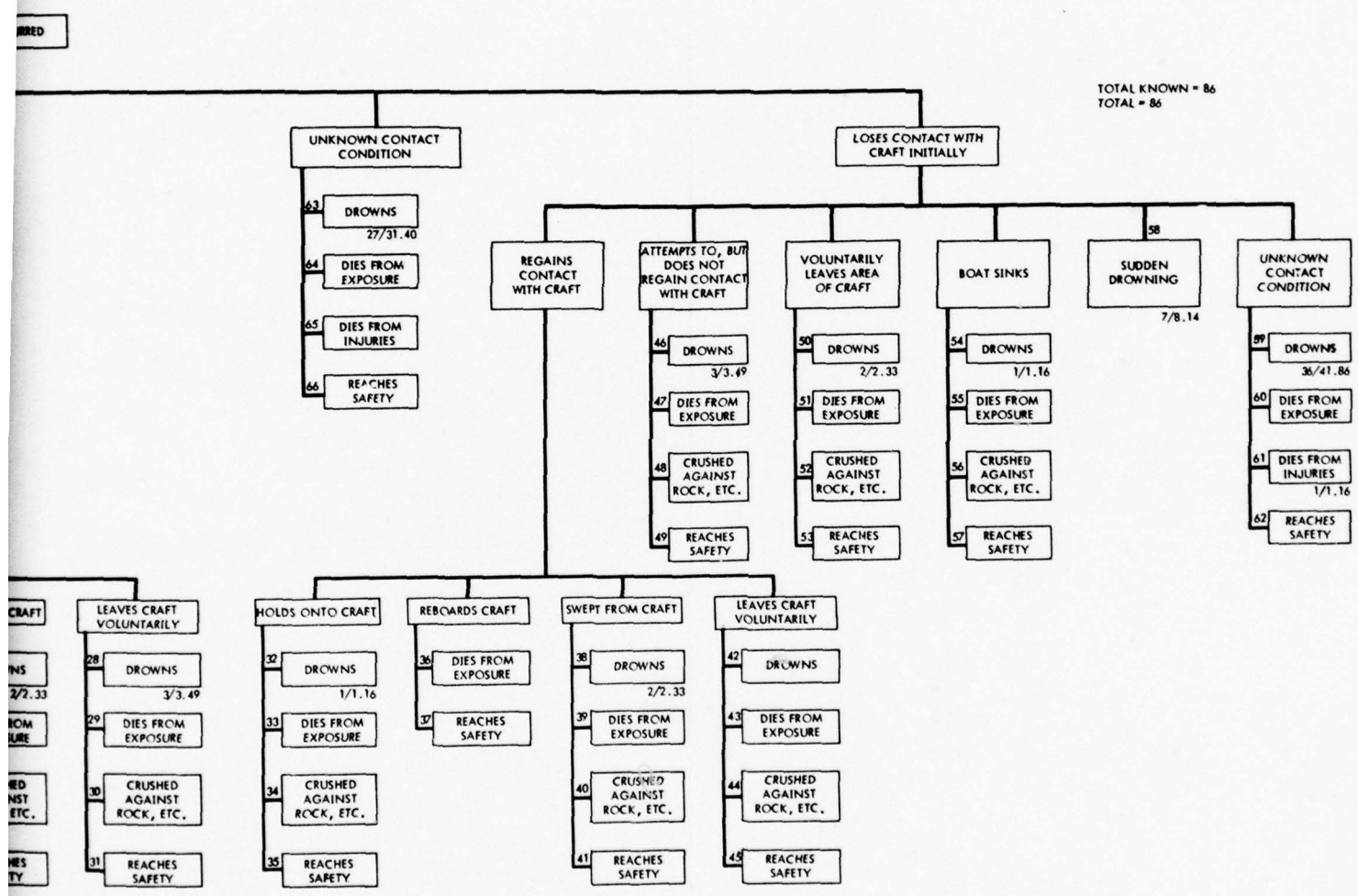


* NUMBER OF OCCURRENCES/PERCENT OF TOTAL KNOWN OCCURRENCES

TALITIES

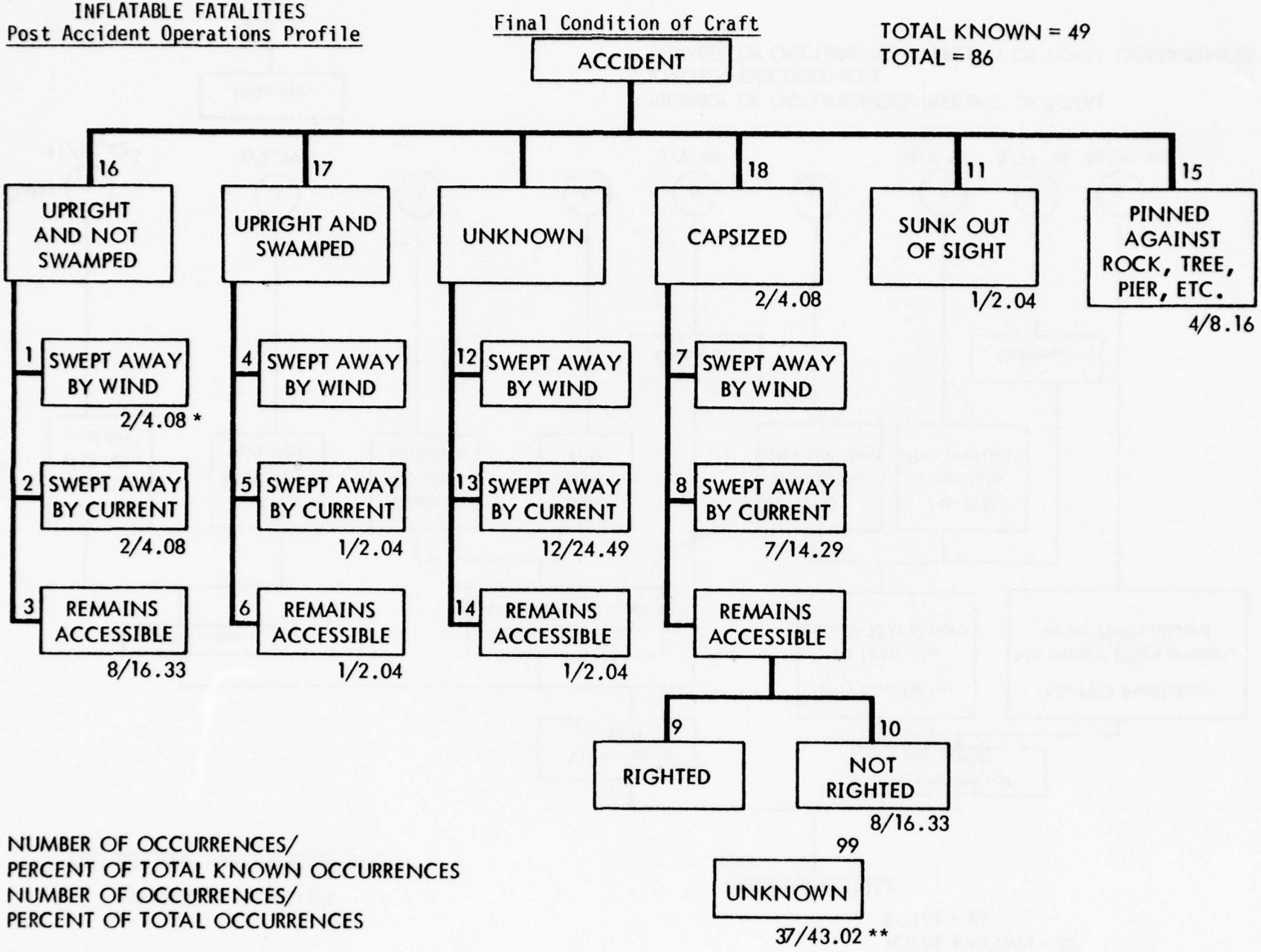
ations Profile

dent Situation



B-43/B-44

INFLATABLE FATALITIES
Post Accident Operations Profile

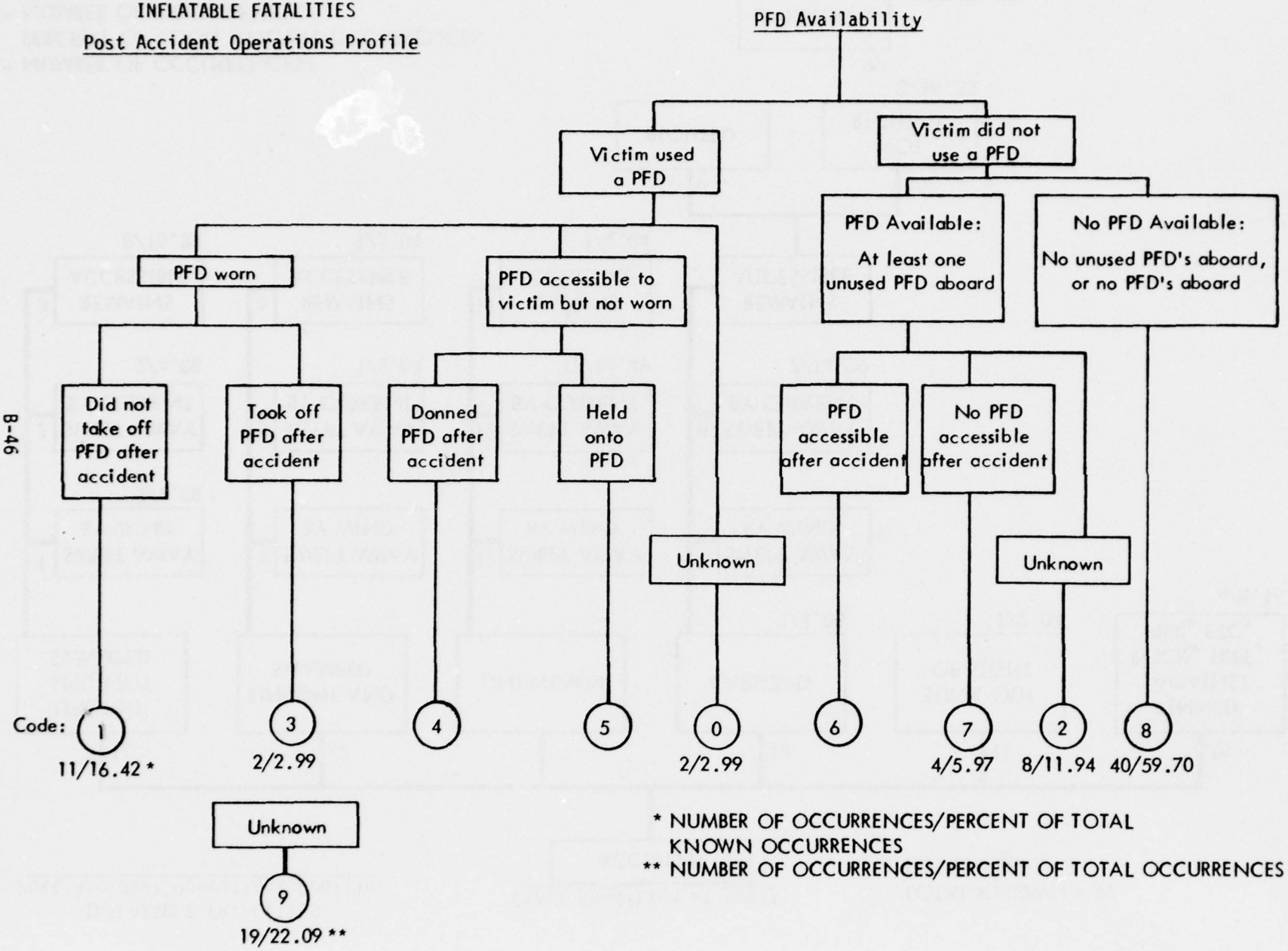


* NUMBER OF OCCURRENCES/
PERCENT OF TOTAL KNOWN OCCURRENCES
** NUMBER OF OCCURRENCES/
PERCENT OF TOTAL OCCURRENCES

TOTAL KNOWN = 67
TOTAL = 86

INFLATABLE FATALITIES

Post Accident Operations Profile

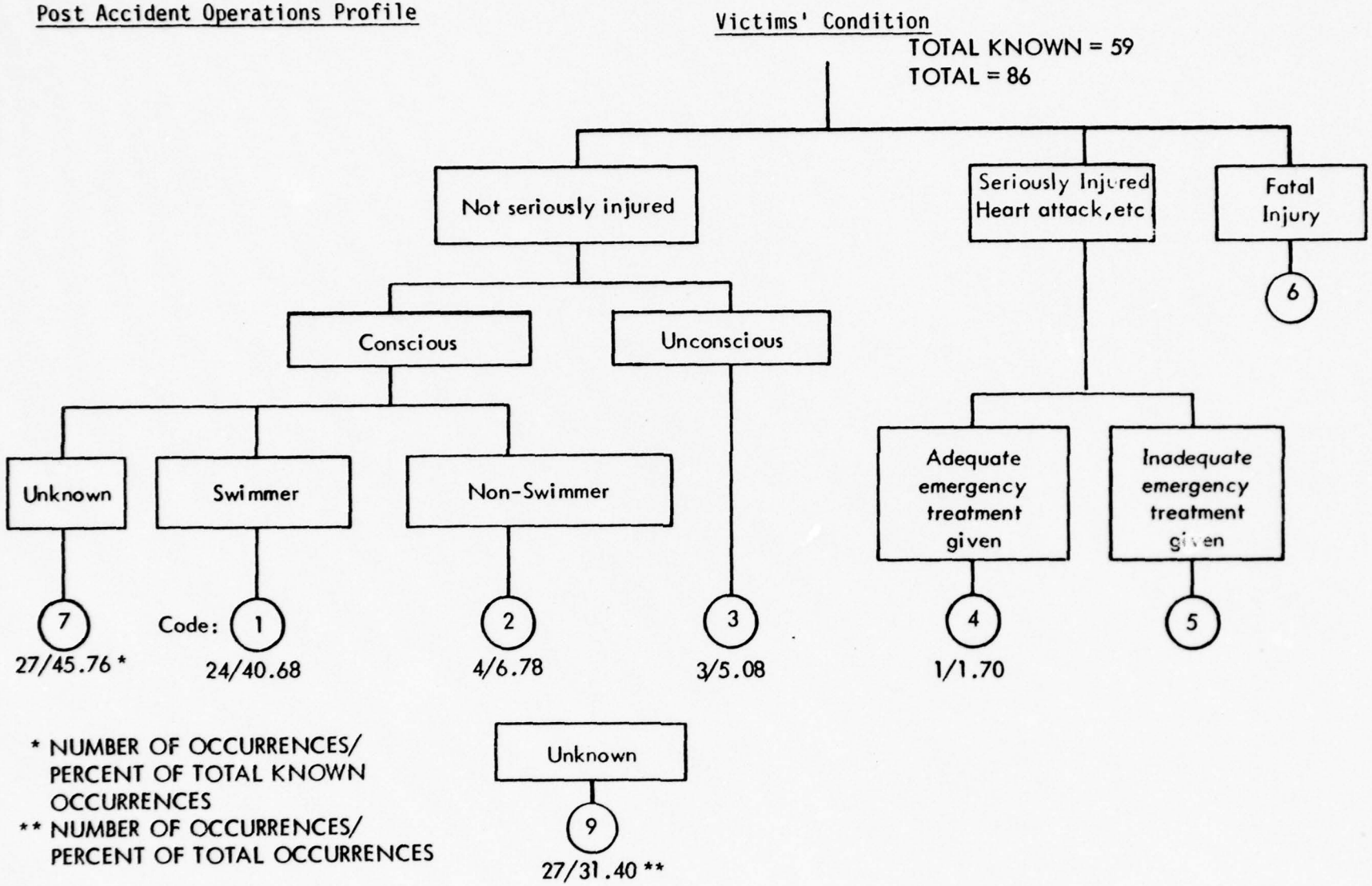


* NUMBER OF OCCURRENCES/PERCENT OF TOTAL KNOWN OCCURRENCES

** NUMBER OF OCCURRENCES/PERCENT OF TOTAL OCCURRENCES

INFLATABLE FATALITIES

Post Accident Operations Profile



* NUMBER OF OCCURRENCES/ PERCENT OF TOTAL KNOWN OCCURRENCES

** NUMBER OF OCCURRENCES/ PERCENT OF TOTAL OCCURRENCES

8-47/8-48

APPENDIX C. CROSS SORTS OF CODED VARIABLES FOR FATAL CANOE/KAYAK AND INFLATABLE CRAFT ACCIDENTS

PFD ON BOARD

PERSONS ON BOARD	0	1	2	3	4	5	6	7	8	UNK
1	14	8	1							7
2	30	3	68	2	2	1				18
3	17	1	2	18			1			7
4	6		5	1	4					
5	5		1		1					
6										
7										
8										
9										
UNK										3

CANOE FATALITIES

FINAL BOAT CONDITION	WIND					
	NONE	LIGHT	MODERATE	STRONG	STORM	UNKNOWN
Upright, Not Swamped						
Swept Away By Wind	1					
Swept Away By Current						
Remains Accessible		2				2
Upright And Swamped		1				
Swept Away By Wind						
Swept Away By Current						
Remains Accessible		5	2	3		1
Capsized						
Swept Away By Wind						
Swept Away By Current	1	1	1			
Remains Accessible						
Righted	2	1	1	1		
Not Righted	6	11	3	4	1	4
Unknown Attitude						
Swept Away By Wind				2		1
Swept Away By Current	1	6				2
Remains Accessible	9	8	7	1		4
Sunk Out Of Sight	1			1		1
Pinned Against Rock, Tree, Etc.	2	2				1
Unknown Condition	17	46	14	11	2	33

CANOE FATALITIES

TYPE OF WATER	PERSONS ON BOARD									
	1	2	3	4	5	6	7	8	9	UNKNOWN
Still	23	30	17	12	4					1
Slow	1	17	6	1						
Fast	3	28	10	2						
Rapids		20	4	2	1					
Falls		4								
Dam	1	22	7							
Unknown	2	3	1		2					2

CANOE FATALITIES

PFD AVAILABILITY AND USE	PFD TYPE									
	APPROVED				NON-APPROVED			OTHER FLOTAT.	NO FLOTAT.	UNK
	UNK	TYPE II	TYPE III	TYPE IV	SKI BELT	INF/AYK	OTHER			
VICTIM USED A PFD										
PFD WORN										
Left PFD On	15	3	2		1	1				
Took PFD Off	3									
PFD NOT WORN		1								
Donned										
Held Onto	2	1		3						
Unknown How Used	4									
Victim Did Not Use PFD										
PFD Available										
Accessible	3			1					1	
Not Accessible	7			4						
Unknown Accessibility	36	3	1	5						
No PFD Available	1							3	76	2
Unknown Use Condition	4	5		3					3	32

CANOE FATALITIES

PFD AVAILABILITY AND USE	PERSONS ON BOARD									
	1	2	3	4	5	6	7	8	9	UNKNOWN
Victim Used A PFD										
PFD Worn										
Left PFD On	2	18	2							
Took PFD Off	1	1	1							
PFD Not Worn										
Donned		1								
Held Onto		5	1							
Unknown How Used		4								
Victim Did Not Use PFD										
PFD Available										
Accessible	1	2		2						
Not Accessible	1	6	1	3						
Unknown Accessibility	4	29	11		1					
No PFD Available	14	32	21	9	6					
Unknown Use Condition	7	26	8	3						3

CANOE FATALITIES

PFD AVAILABILITY/USE	TYPE OF WATER						
	Still	Slow	Fast	Rapids	Falls	Dam	Unknown
Victim Used A PFD							
PFD Worn							
Left PFD On	6	1	3	2	1	8	1
Took PFD Off	2			1			
PFD Not Worn							
Donned				1			
Held On		1	1	1		3	
Unknown How Used	1		1	2			
Victim Did Not Use PFD							
PFD Available							
Accessible	3	1	1				
Not Accessible	5	1	3			2	
Unknown Accessibility	16	5	9	7	2	6	
No PFD Available	41	9	18	7	1	3	3
Unknown Use Condition	13	7	7	6		8	6

CANOE FATALITIES

FINAL BOAT CONDITION	WATER CONDITIONS				
	CALM	CHOPPY	ROUGH	RAPIDS, FALLS, DAM	UNKNOWN
Upright, Not Swamped					
Swept Away By Wind	1				
Swept Away By Current					
Remains Accessible	4				
Upright And Swamped	1				
Swept Away By Wind					
Swept Away By Current					
Remains Accessible	4	1	4		2
Capsized					
Swept Away By Wind					
Swept Away By Current	2			1	
Remains Accessible					
Righted	2		1	2	
Not Righted	14	2	6	4	3
Unknown Attitude					
Swept Away By Wind		1	2		
Swept Away By Current		1	3	4	1
Remains Accessible	12	3	2	10	2
Sunk Out of Sight	1		1	1	
Pinned Against Rock, Tree, Etc.				4	1
Unknown Condition	30	7	26	36	24

CANOE FATALITIES

WIND	WATER TYPE						
	STILL	SLOW	FAST	RAPIDS	FALLS	DAM	UNK
None	17	2	3	6		10	2
Light (0-6 mph)	30	10	21	9	2	10	1
Moderate (7-14 mph)	9	1	8	8	2		
Strong (15-25 mph)	17	3	3				
Storm (over 25 mph)	3						
Unknown	11	9	8	4		10	7

WATER CONDITIONS	TYPE OF WATER						
	STILL	SLOW	FAST	RAPIDS	FALLS	DAM	UNK
Calm	51	15	3			1	1
Choppy	11	2	2				
Rough	20	2	22				1
Rapids, Falls, Dam			2		4	29	
Unknown	5	6	14	27			8

WIND	WATER CONDITIONS				
	CALM	CHOPPY	ROUGH	RAPIDS FALLS,DAM	UNK
None	22			15	3
Light (0-6 mph)	39	4	12	23	5
Moderate (7-14 mph)	1	8	7	10	2
Strong (15-25 mph)	2	1	20		
Storm (over 25 mph)			3		
Unknown	7	2	3	14	23

CANOE FATALITIES

MONTH	TYPE OF WATER						
	STILL	SLOW	FAST	RAPIDS	FALLS	DAM	UNKNOWN
January	1	3		1			
February		1	2				1
March	3	3	3	5		10	
April	10	2	9	5		2	3
May	19	3	8	7	1	7	4
June	11	6	9	5	2	4	1
July	12	1	4	2		4	
August	15	2	1	1		1	
September	5	2			1	2	
October	3	2	6	1			
November	5		1				1
December	3						

TYPE OF WATER	PFD ON BOARD							
	0	1	2	3	4	5	6	UNKNOWN
Still	36	10	23	7	4			7
Slow	6	1	6	4	2			6
Fast	17		15	5	1			5
Rapids	6		14	2		1	1	3
Falls	1		2	1				
Dam	3		17	2				8
Unknown	3	1						6

CANOE FATALITIES

FINAL BOAT CONDITION	TYPE OF WATER						
	STILL	SLOW	FAST	RAPIDS	FALLS	DAM	UNKNOWN
Upright Not Swamped							
Swept Away By Wind	1						
Swept Away By Current							
Remains Accessible	3	1					
Upright And Swamped	1						
Swept Away By Wind							
Swept Away By Current							
Remains Accessible	4	4	3				
Capsized							
Swept Away By Wind							
Swept Away By Current		2		1			
Remains Accessible							
Righted	3			2			
Not Righted	17	3	5	3	1		
Unknown Attitude							
Swept Away By Wind	2		1				
Swept Away By Current			5	2	1	1	
Remains Accessible	15	2	2	5	1	3	1
Sunk Out Of Sight	2					1	
Pinned Against Rock, Tree, Etc.			2	1		2	
Unknown Condition	39	13	25	13	1	23	9

CANOE FATALITIES

PFD AVAILABILITY AND USE	WATER TEMPERATURE																														
	32°	34°	35°	36°	38°	39°	40°	42°	45°	47°	50°	51°	54°	56°	60°	65°	67°	68°	69°	70°	72°	74°	75°	78°	80°	84°	87°	WARM	COLD	VERY COLD	UNKNOWN
Victim Used PFD																															
PFD Worn																															
Left PFD On		1					1	1			1			3	1			2			1							2	7	1	1
Took PFD Off											1																	1	1		13
PFD Not Worn																															
Donned						1																									
Held Onto				1			1																						2	1	1
Unknown How Used														1														1			
Victim Did Not Use PFD																															
PFD Available																															
Accessible											1												1					1	1		1
Not Accessible										1	1													1				2		1	5
Unknown Accessibility			1		1		2				1	1			3	2				1		1			1	1		6	11		2
No PFD Available	1	1		2	2	6	2	2	1	1	2		2		1	5				2	1	1			1		1	8	17	2	20
Unknown Use Condition							3		3		1						2		1									4	14	2	18

CANOE SURVIVORS

FINAL BOAT CONDITION	WIND					
	NONE	LIGHT	MODERATE	STRONG	STORM	UNKNOWN
Upright, Not Swamped						
Swept Away By Wind						
Swept Away By Current						
Remains Accessible						4
Upright And Swamped						
Swept Away By Wind						
Swept Away By Current						
Remains Accessible	4	4	2	1		1
Capsized						
Swept Away By Wind						
Swept Away By Current	1	2	1			
Remains Accessible						
Righted	2	1	1	2		
Not Righted	4	9	5	1	1	7
Unknown Attitude						
Swept Away By Wind				1		
Swept Away By Current	1	7				5
Remains Accessible	8	9	12	3		6
Sunk Out Of Sight	1					2
Pinned Against Rock, Tree, Etc.	3	2				1
Unknown Condition	10	49	17	9		30

CANOE SURVIVORS

FINAL BOAT CONDITION	WATER CONDITIONS				
	CALM	CHOPPY	ROUGH	RAPIDS, FALLS, DAM	UNKNOWN
Upright, Not Swamped					
Swept Away By Wind					
Swept Away By Current					
Remains Accessible	4				
Upright And Swamped					
Swept Away By Wind					
Swept Away By Current					
Remains Accessible	5	1	2		4
Capsized					
Swept Away By Wind					
Swept Away By Current	3			1	
Remains Accessible					
Righted	2		2	2	
Not Righted	14	2	3	6	2
Unknown Attitude					
Swept Away By Wind			1		
Swept Away By Current		2	3	7	1
Remains Accessible	15	4	4	12	3
Sunk Out of Sight	2			1	
Pinned Against Rock, Tree, Etc.				5	1
Unknown Condition	36	9	21	28	21

CANOE SURVIVORS

FINAL BOAT CONDITION	TYPE OF WATER						
	STILL	SLOW	FAST	RAPIDS	FALLS	DAM	UNKNOWN
Upright Not Swamped							
Swept Away By Wind							
Swept Away By Current							
Remains Accessible	3	1					
Upright And Swamped							
Swept Away By Wind							
Swept Away By Current							
Remains Accessible	7	2	3				
Capsized							
Swept Away By Wind							
Swept Away By Current		3		1			
Remains Accessible							
Righted	4			2			
Not Righted	16	1	4	5	1		
Unknown Attitude							
Swept Away By Wind			1				
Swept Away By Current			6	5	1	1	
Remains Accessible	19	4	2	9	1	1	2
Sunk Out Of Sight	2					1	
Pinned Against Rock, Tree, Etc.			2	2		2	
Unknown	39	9	32	18	1	10	6

CANOE SURVIVORS

FINAL BOAT CONDITION	DISTANCE FROM SHORE*															
	0	1	2	3	4	5	6	9	10	12	13	18	25	60	98	99
Upright And Not Swamped																
Swept Away By Wind																
Swept Away By Current																
Remains Accessible		1		3												
Upright And Swamped																
Swept Away By Wind																
Swept Away By Current																
Remains Accessible					4					2				1		5
Capsized																
Swept Away By Wind																
Swept Away By Current																
Remains Accessible			2													2
Righted		2	2													2
Not Righted		8	6						2				1			10
Unknown Attitude																
Swept Away By Wind																1
Swept Away By Current		5														8
Remains Accessible		10	3	4	5		4				2			1		9
Sunk Out of Sight		3														2
Pinned Against Rock, Tree, Etc.		4														
Unknown Condition		31	12	6	1		3	1								61

* In increments of 50 ft.

CANOE SURVIVORS

PFD AVAILABILITY AND USE	PERSONS ON BOARD									
	1	2	3	4	5	6	7	8	9	UNKNOWN
Victim Used A PFD										
PFD Worn										
Left PFD On		14	8	7	2					
Took PFD Off										
PFD Not Worn										
Donned		3								
Held Onto		2	1	3						
Unknown How Used		6								
Victim Did Not Use PFD										
PFD Available										
Accessible				1						
Not Accessible		5	2	1						
Unknown Accessibility		18	11	4	4					
No PFD Available	1	22	33	21	12					
Unknown Use Condition		20	22	6						

CANOE SURVIVORS

PFD AVAILABILITY AND USE	PFD TYPE									
		APPROVED			NON-APPROVED			OTHER	NO	
	UNK	TYPE II	TYPE III	TYPE IV	SKI BELT	INF/AYK	OTHER	FLOTAT.	FLOTAT.	UNK
VICTIM USED A PFD										
PFD WORN										
Left PFD On	24	2	2		2	1				
Took PFD Off										
PFD NOT WORN										
Donned		3								
Held Onto	4			2						
Unknown How Used	6									
Victim Did Not Use PFD										
PFD Available										
Accessible	1									
Not Accessible	6			2						
Unknown Accessibility	26	2	1	8						
No PFD Available	2							3	79	5
Unknown Use Condition	7			2					9	30

CANOE SURVIVORS.

PFD ON BOARD

PERSONS ON BOARD	0	1	2	3	4	5	6	7	8	UNK
1	1									
2	22	3	46	2		1				16
3	28		7	26			2			14
4	14	3	11	3	12					
5	10		4		4					
6										
7										
8										
9										
UNK										

CANOE SURVIVORS

PFD AVAILABILITY/USE	TYPE OF WATER						
	Still	Slow	Fast	Rapids	Falls	Dam	Unknown
Victim Used A PFD							
PFD Worn							
Left PFD On	15	2	2	8	1	3	
Took PFD Off							
PFD Not Worn							
Donned				3			
Held On	3		3				
Unknown How Used	1		3	2			
Victim Did Not Use PFD							
PFD Available							
Accessible	1						
Not Accessible	1	1	4			2	
Unknown Accessibility	17	4	5	6	2	3	
No PFD Available	39	8	18	16	1	2	5
Unknown Use Condition	13	5	15	7		5	3

CANOE SURVIVORS

WIND	WATER TYPE						
	STILL	SLOW	FAST	RAPIDS	FALLS	DAM	UNK
None	14	2	3	7		5	3
Light (0-6 mph)	35	7	25	9	2	3	2
Moderate (7-14 mph)	12	1	5	18	2		
Strong (15-25 mph)	12	4	1				
Storm (over 25 mph)	1						
Unknown	16	6	16	8		7	3

WATER CONDITIONS	TYPE OF WATER						
	STILL	SLOW	FAST	RAPIDS	FALLS	DAM	UNK
Calm	64	12	2			1	2
Choppy	13	2	3				
Rough	10	3	22				1
Rapids, Falls, Dam			2	42	4	14	
Unknown	3	3	21				5

WIND	WATER CONDITIONS				
	CALM	CHOPPY	ROUGH	RAPIDS FALLS, DAM	UNK
None	18		1	11	4
Light (0-6 mph)	42	5	14	16	6
Moderate (7-14 mph)	2	10	6	20	
Strong (15-25 mph)	4	2	11		
Storm (over 25 mph)			1		
Unknown	15	1	3	15	22

CANOE SURVIVORS

MONTH	TYPE OF WATER						
	STILL	SLOW	FAST	RAPIDS	FALLS	DAM	UNKNOWN
January	1	1		3			
February		1	2			2	
March	2	2	5	8		3	
April	7	2	13	8		2	1
May	23	5	9	10	1	5	3
June	18	3	9	8	2	1	1
July	12	1	4	2		2	
August	11	2	1	1		1	
September	4	1			1	1	
October	7	2	6	2			
November	2		1				1
December	3						

TYPE OF WATER	PFD ON BOARD							
	0	1	2	3	4	5	6	UNKNOWN
Still	33	2	26	13	13			3
Slow	4	3	4	4				5
Fast	16		12	7	3			12
Rapids	14		17	5		1	2	3
Falls	1		2	1				
Dam	2		7	1				5
Unknown	5	1						2

CANOE SURVIVORS

TYPE OF WATER	PERSONS ON BOARD									
	1	2	3	4	5	6	7	8	9	UNKNOWN
Still		22	33	24	11					
Slow		11	6	3						
Fast	1	20	23	6						
Rapids		20	8	10	4					
Falls		4								
Dam		10	5							
Unknown		3	2		3					

CANOE FATALITIES - STILL/SLOW WATER

FINAL BOAT CONDITION	TYPE OF WATER						
	STILL	SLOW	FAST	RAPIDS	FALLS	DAM	UNKNOWN
Upright Not Swamped							
Swept Away By Wind	1						
Swept Away By Current							
Remains Accessible	3	1					
Upright And Swamped	1						
Swept Away By Wind							
Swept Away By Current							
Remains Accessible	4	4					
Capsized							
Swept Away By Wind							
Swept Away By Current		2					
Remains Accessible							
Righted	3						
Not Righted	17	3					
Unknown Attitude							
Swept Away By Wind	2						
Swept Away By Current							
Remains Accessible	15	2					
Sunk Out Of Sight	2						
Pinned Against Rock, Tree, Etc.							
Unknown Condition	39	13					

CANOE FATALITIES - STILL/SLOW WATER

FINAL BOAT CONDITION	WIND					
	NONE	LIGHT	MODERATE	STRONG	STORM	UNKNOWN
Upright, Not Swamped						
Swept Away By Wind	1					
Swept Away By Current						
Remains Accessible		2				2
Upright And Swamped		1				
Swept Away By Wind						
Swept Away By Current						
Remains Accessible		4	2	1		1
Capsized						
Swept Away By Wind						
Swept Away By Current	1	1				
Remains Accessible						
Righted	2			1		
Not Righted	2	9	1	4	1	3
Unknown Attitude						
Swept Away By Wind				1		1
Swept Away By Current						
Remains Accessible	6	5	4	1		1
Sunk Out Of Sight				1		1
Pinned Against Rock, Tree, Etc.						
Unknown Condition	7	18	3	11	2	11

CANOE FATALITIES - STILL/SLOW WATER

FINAL BOAT CONDITION	WATER CONDITIONS				
	CALM	CHOPPY	ROUGH	RAPIDS, FALLS, DAM	UNKNOWN
Upright, Not Swamped					
Swept Away By Wind	1				
Swept Away By Current					
Remains Accessible	4				
Upright And Swamped	1				
Swept Away By Wind					
Swept Away By Current					
Remains Accessible	4	1	2		1
Capsized					
Swept Away By Wind					
Swept Away By Current	2				
Remains Accessible					
Righted	2		1		
Not Righted	12	2	5		1
Unknown Attitude					
Swept Away By Wind		1	1		
Swept Away By Current					
Remains Accessible	11	3	2		1
Sunk Out of Sight	1		1		
Pinned Against Rock, Tree, Etc.					
Unknown Condition	28	6	10		8

CANOE FATALITIES - STILL/SLOW WATER

PFD ON BOARD

PERSONS ON BOARD	0	1	2	3	4	5	6	7	8	UNK
1	11	8	1							4
2	15	2	22	1	2					5
3	9		1	10						3
4	4	1	5		3					
5	3				1					
6										
7										
8										
9										
UNK										1

CANOE FATALITIES - STILL/SLOW WATER

TYPE OF WATER	PERSONS ON BOARD									
	1	2	3	4	5	6	7	8	9	UNKNOWN
Still	23	30	17	12	4					1
Slow	1	17	6	1						
Fast										
Rapids										
Falls										
Dam										

CANOE FATALITIES - STILL/SLOW WATER

PFD AVAILABILITY AND USE	PERSONS ON BOARD									
	1	2	3	4	5	6	7	8	9	UNKNOWN
Victim Used A PFD										
PFD Worn										
Left PFD On	2	4	1							
Took PFD Off	1		1							
PFD Not Worn										
Donned										
Held Onto		1								
Unknown How Used		1								
Victim Did Not Use PFD										
PFD Available										
Accessible	1	2		1						
Not Accessible	1	2		3						
Unknown Accessibility	4	10	6		1					
No PFD Available	11	17	12	7	3					
Unknown Use Condition	4	10	3	2						1

CANOE FATALITIES - STILL/SLOW WATER

PFD AVAILABILITY AND USE	PFD TYPE									
	APPROVED				NON-APPROVED			OTHER FLOTAT.	NO FLOTAT.	UNK
	UNK	TYPE II	TYPE III	TYPE IV	SKI BELT	INF/AYK	OTHER			
VICTIM USED A PFD										
PFD WORN										
Left PFD On	5	1				1				
Took PFD Off	2									
PFD NOT WORN										
Donned										
Held Onto		1								
Unknown How Used	1									
Victim Did Not Use PFD										
PFD Available										
Accessible	2			1					1	
Not Accessible	4			2						
Unknown Accessibility	18	1		2						
No PFD Available	1							1	47	1
Unknown Use Condition	2	3		2					1	12

CANOE FATALITIES - STILL/SLOW WATER

MONTH	TYPE OF WATER						
	STILL	SLOW	FAST	RAPIDS	FALLS	DAM	UNKNOWN
January	1	3					
February		1					
March	3	3					
April	10	2					
May	19	3					
June	11	6					
July	12	1					
August	15	2					
September	5	2					
October	3	2					
November	5						
December	3						

TYPE OF WATER	PFD ON BOARD							
	0	1	2	3	4	5	6	UNKNOWN
Still	36	10	23	7	4			7
Slow	6	1	6	4	2			6
Fast								
Rapids								
Falls								
Dam								

CANOE FATALITIES - STILL/SLOW WATER

WIND	WATER TYPE						
	STILL	SLOW	FAST	RAPIDS	FALLS	DAM	UNK
None	17	2					
Light (0-6 mph)	30	10					
Moderate (7-14 mph)	9	1					
Strong (15-25 mph)	17	3					
Storm (over 25 mph)	3						
Unknown	11	9					

WATER CONDITIONS	TYPE OF WATER						
	STILL	SLOW	FAST	RAPIDS	FALLS	DAM	UNK
Calm	51	15					
Choppy	11	2					
Rough	20	2					
Rapids, Falls, Dam							
Unknown	5	6					

WIND	WATER CONDITIONS				
	CALM	CHOPPY	ROUGH	RAPIDS FALLS, DAM	UNK
None	19				
Light (0-6 mph)	37	3			
Moderate (7-14 mph)	1	7	2		
Strong (15-25 mph)	2	1	17		
Storm (over 25 mph)			3		
Unknown	7	2			11

CANOE FATALITIES - STILL/SLOW WATER

PFD AVAILABILITY/USE	TYPE OF WATER						
	Still	Slow	Fast	Rapids	Falls	Dam	Unknown
Victim Used A PFD							
PFD Worn							
Left PFD On	6	1					
Took PFD Off	2						
PFD Not Worn							
Donned							
Held On		1					
Unknown How Used	1						
Victim Did Not Use PFD							
PFD Available							
Accessible	3	1					
Not Accessible	5	1					
Unknown Accessibility	16	5					
No PFD Available	41	9					
Unknown Use Condition	13	7					

CANOE FATALITIES - STILL/SLOW WATER

FINAL BOAT CONDITION	TYPE OF WATER						
	STILL	SLOW	FAST	RAPIDS	FALLS	DAM	UNKNOWN
Upright Not Swamped							
Swept Away By Wind	1						
Swept Away By Current							
Remains Accessible	3	1					
Upright And Swamped	1						
Swept Away By Wind							
Swept Away By Current							
Remains Accessible	4	4					
Capsized							
Swept Away By Wind							
Swept Away By Current		2					
Remains Accessible							
Righted	3						
Not Righted	17	3					
Unknown Attitude							
Swept Away By Wind	2						
Swept Away By Current							
Remains Accessible	15	2					
Sunk Out Of Sight	2						
Pinned Against Rock, Tree, Etc.							
Unknown Condition	39	13					

CANOE FATALITIES - STILL/SLOW WATER

FINAL BOAT CONDITION	WATER CONDITIONS				
	CALM	CHOPPY	ROUGH	RAPIDS, FALLS, DAM	UNKNOWN
Upright, Not Swamped					
Swept Away By Wind	1				
Swept Away By Current					
Remains Accessible	4				
Upright And Swamped	1				
Swept Away By Wind					
Swept Away By Current					
Remains Accessible	4	1	2		1
Capsized					
Swept Away By Wind					
Swept Away By Current	2				
Remains Accessible					
Righted	2		1		
Not Righted	12	2	5		1
Unknown Attitude					
Swept Away By Wind		1	1		
Swept Away By Current					
Remains Accessible	11	3	2		1
Sunk Out of Sight	1		1		
Pinned Against Rock, Tree, Etc.					
Unknown Condition	28	6	10		8

CANOE FATALITIES - STILL/SLOW WATER

FINAL BOAT CONDITION	WIND					
	NONE	LIGHT	MODERATE	STRONG	STORM	UNKNOWN
Upright, Not Swamped						
Swept Away By Wind	1					
Swept Away By Current						
Remains Accessible		2				2
Upright And Swamped		1				
Swept Away By Wind						
Swept Away By Current						
Remains Accessible		4	2	1		1
Capsized						
Swept Away By Wind						
Swept Away By Current	1	1				
Remains Accessible						
Righted	2			1		
Not Righted	2	9	1	4	1	3
Unknown Attitude						
Swept Away By Wind				1		1
Swept Away By Current						
Remains Accessible	6	5	4	1		1
Sunk Out Of Sight				1		1
Pinned Against Rock, Tree, Etc.						
Unknown Condition	7	18	3	11	2	11

CANOE FATALITIES - STILL/SLOW WATER

PFD AVAILABILITY AND USE	WATER TEMPERATURE																									
	34°	36°	38°	39°	40°	42°	45°	47°	50°	51°	56°	60°	65°	67°	69°	70°	72°	74°	75°	78°	80°	84°	87°	NOT RELEVANT	COLD	VERY COLD	UNKNOWN
Victim Used PFD																											
PFD Worn																											
Left PFD On	1										3														3		
Took PFD Off																						1			1		7
PFD Not Worn																											
Donned																											
Held Onto					1																						
Unknown How Used																											
Victim Did Not Use PFD																											
PFD Available																											
Accessible									1										1					1			1
Not Accessible																				1				1			4
Unknown Accessibility										1	1	1				1		1			1	1		6	2		
No PFD Available	1	1	2	4	2	1	1	1	2				3		1	1	1				1		1	6	9	2	10
Unknown					3		1							2										4	4	1	5

INFLATABLE FATALITIES

FINAL BOAT CONDITION	WIND					
	NONE	LIGHT	MODERATE	STRONG	STORM	UNKNOWN
Upright, Not Swamped						
Swept Away By Wind				2		
Swept Away By Current	1					1
Remains Accessible	1	3	2	1		1
Upright And Swamped						
Swept Away By Wind						
Swept Away By Current			1			
Remains Accessible	1					
Capsized		1				1
Swept Away By Wind						
Swept Away By Current	1	5				1
Remains Accessible						
Righted						
Not Righted		3	1	1		3
Unknown Attitude						
Swept Away By Wind						
Swept Away By Current	6	2	2	1		1
Remains Accessible	1					
Sunk Out Of Sight	1					
Pinned Against Rock, Tree, Etc.		1				3
Unknown Condition	1	10	5		1	20

INFLATABLE FATALITIES

PFD ON BOARD

PERSONS ON BOARD	0	1	2	3	4	5	6	7	8	UNK
1	7									6
2	22	1	11							12
3	6	1	3	2						1
4	1		1		1					2
5	1									2
6							6			
7										
8										
9										
UNK										

INFLATABLE FATALITIES

TYPE OF WATER	PERSONS ON BOARD									
	1	2	3	4	5	6	7	8	9	UNKNOWN
Still	3	4				2				
Slow	3		1							
Fast	5	16	5	1	4	3				
Rapids	1	13	3	2		1				
Falls	1	1	1							
Dam		12	3	1						

INFLATABLE FATALITIES

MONTH	TYPE OF WATER						
	STILL	SLOW	FAST	RAPIDS	FALLS	DAM	UNKNOWN
January			1				
February			4	1		2	
March	1		3	1		2	
April			1	6		4	
May	1	1	8	7	1	2	
June	2		11	4		4	
July	4	2	4	1	1	1	
August	1	1	1			1	
September			1				
October							
November					1		
December							

TYPE OF WATER	PFD ON BOARD							
	0	1	2	3	4	5	6	UNKNOWN
Still	5		1				2	1
Slow								4
Fast	15	1	4	1			3	10
Rapids	8		4	1			1	6
Falls	3							
Dam	6	1	6		1			2

INFLATABLE FATALITIES

WIND	WATER TYPE						
	STILL	SLOW	FAST	RAPIDS	FALLS	DAM	UNK
None	1		7	3		2	
Light (0-6 mph)	2	1	10	3	2	7	
Moderate (7-14 mph)	3		3	2		3	
Strong (15-25 mph)	2	1				2	
Storm (over 25 mph)			1				
Unknown	1	2	13	12	1	2	

WATER CONDITIONS	TYPE OF WATER						
	STILL	SLOW	FAST	RAPIDS	FALLS	DAM	UNK
Calm	6	1	1				
Choppy	3	1	2				
Rough			14	1			
Rapids, Falls, Dam			5	19	3	16	
Unknown		2	12				

WIND	WATER CONDITIONS				
	CALM	CHOPPY	ROUGH	RAPIDS FALLS,DAM	UNK
None	1	2	3	5	2
Light (0-6 mph)	2	1	4	15	3
Moderate (7-14 mph)	3		2	5	1
Strong (15-25 mph)		3		2	
Storm (over 25 mph)			1		
Unknown	2		5	16	8

INFLATABLE FATALITIES

FINAL BOAT CONDITION	DISTANCE FROM SHORE*															
	0	1	2	3	4	5	6	9	10	12	13	18	25	60	98	99
Upright And Not Swamped																
Swept Away By Wind		1														1
Swept Away By Current																2
Remains Accessible		1	1	1	1											4
Upright And Swamped																
Swept Away By Wind																
Swept Away By Current																1
Remains Accessible				1												
Capsized																2
Swept Away By Wind																
Swept Away By Current		3	2													2
Remains Accessible																
Righted																
Not Righted		4									1					3
Unknown Attitude																
Swept Away By Wind																
Swept Away By Current	1	6	1													4
Remains Accessible			1													
Sunk Out of Sight		1														
Pinned Against Rock, Tree, Etc.		2														2
Unknown Condition	1	4	4	2			1									25

* In increments of 50 ft.

INFLATABLE FATALITIES

FINAL BOAT CONDITION	TYPE OF WATER						
	STILL	SLOW	FAST	RAPIDS	FALLS	DAM	UNKNOWN
Upright Not Swamped							
Swept Away By Wind	1	1					
Swept Away By Current			1	1			
Remains Accessible	4		2			2	
Upright And Swamped							
Swept Away By Wind							
Swept Away By Current				1			
Remains Accessible			1				
Capsized			2				
Swept Away By Wind							
Swept Away By Current			4	1		2	
Remains Accessible							
Righted							
Not Righted	3				1	4	
Unknown Attitude							
Swept Away By Wind							
Swept Away By Current			7	2	1	2	
Remains Accessible	1						
Sunk Out Of Sight						1	
Pinned Against Rock, Tree, Etc.			2	2			
Unknown Condition		3	15	13	1	5	

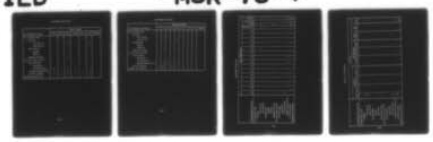
INFLATABLE FATALITIES

FINAL BOAT CONDITION	WATER CONDITIONS				
	CALM	CHOPPY	ROUGH	RAPIDS, FALLS, DAM	UNKNOWN
Upright, Not Swamped					
Swept Away By Wind		2			
Swept Away By Current			1	1	
Remains Accessible	3	1	1	2	1
Upright And Swamped					
Swept Away By Wind					
Swept Away By Current				1	
Remains Accessible					1
Capsized	1				1
Swept Away By Wind					
Swept Away By Current		1	1	3	2
Remains Accessible					
Righted					
Not Righted	2	1		5	
Unknown Attitude					
Swept Away By Wind					
Swept Away By Current		1	6	5	
Remains Accessible	1				
Sunk Out of Sight				1	
Pinned Against Rock, Tree, Etc.			1	3	
Unknown Condition	1		5	22	9

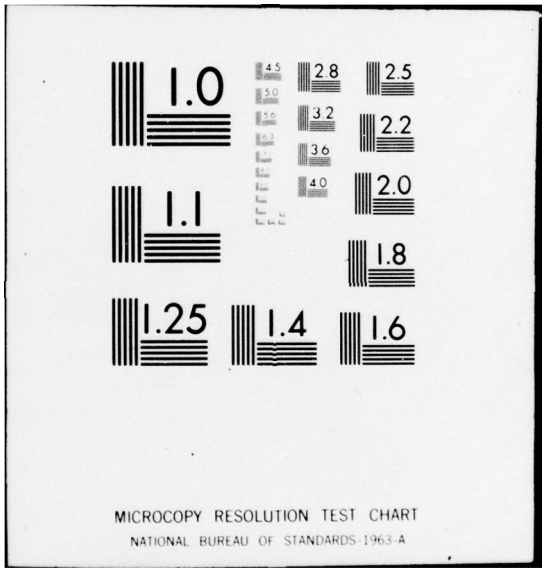
AD-A053 964 WYLE LABS HUNTSVILLE ALA F/G 13/12
CAUSE IDENTIFICATION ANALYSIS OF FATAL ACCIDENT DATA FOR CANOES--ETC(U)
FEB 78 C SAUTKULIS, R DOUGLAS, K GEISSLER DOT-CG-40672-A

UNCLASSIFIED MSR-78-4 USCG-D-17-78 NL

3 OF 3
AD
A053964



END
DATE
FILMED
6-78
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
7.1
8.0
9.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

INFLATABLE FATALITIES

PFD AVAILABILITY/USE	TYPE OF WATER						
	Still	Slow	Fast	Rapids	Falls	Dam	Unknown
Victim Used A PFD							
PFD Worn							
Left PFD On			4	3		4	
Took PFD Off			1			1	
PFD Not Worn							
Donned							
Held On							
Unknown How Used			2				
Victim Did Not Use PFD							
PFD Available							
Accessible							
Not Accessible	2		1	1			
Unknown Accessibility	1	1	1	2		3	
No PFD Available	5		17	9	3	6	
Unknown Use Condition	1	3	8	5		2	

INFLATABLE FATALITIES

PFD AVAILABILITY AND USE	PERSONS ON BOARD									
	1	2	3	4	5	6	7	8	9	UNKNOWN
Victim Used A PFD										
PFD Worn										
Left PFD On		7	1			3				
Took PFD Off		1			1					
PFD Not Worn										
Donned										
Held Onto										
Unknown How Used		1				1				
Victim Did Not Use PFD										
PFD Available										
Accessible										
Not Accessible		1	1			2				
Unknown Accessibility	1	2	3	1	1					
No PFD Available	7	23	7	2	1					
Unknown Use Condition	5	11	1	1	1					

INFLATABLE FATALITIES

PFD AVAILABILITY AND USE	WATER TEMPERATURE																		
	30°	33°	34°	38°	39°	42°	43°	45°	50°	55°	60°	62°	70°	75°	78°	NOT RELEVANT	COLD	VERY COLD	UNKNOWN
Victim Used A PFD																			
PFD Worn																			
Left PFD On											1					1	3		1
Took PFD Off																1			3
PFD Not Worn																			
Donned																			1
Held On																			
Unknown How Used							1										1		
Victim Did Not Use PFD																			
PFD Available																			
Accessible																			
Not Accessible	1																		3
Unknown Accessibility			2					1	1					1					5
No PFD Available		2		1	1	1		1	1	1		1	1		2	3	7	2	16
Unknown Use Condition																	7	1	11

INFLATABLE FATALITIES

PFD AVAILABILITY AND USE	PFD TYPE									
	APPROVED				NON-APPROVED			OTHER FLOTAT.	NO FLOTAT.	UNK
	UNK	TYPE II	TYPE III	TYPE IV	SKI BELT	INF/AYK	OTHER			
VICTIM USED A PFD										
PFD WORN										
Left PFD On	10									1
Took PFD Off	2									
PFD NOT WORN										
Donned										
Held Onto										
Unknown How Used	2									
Victim Did Not Use PFD										
PFD Available										
Accessible										
Not Accessible	2			1				1		
Unknown Accessibility	6					2				
No PFD Available	38									2
Unknown Use Condition										19